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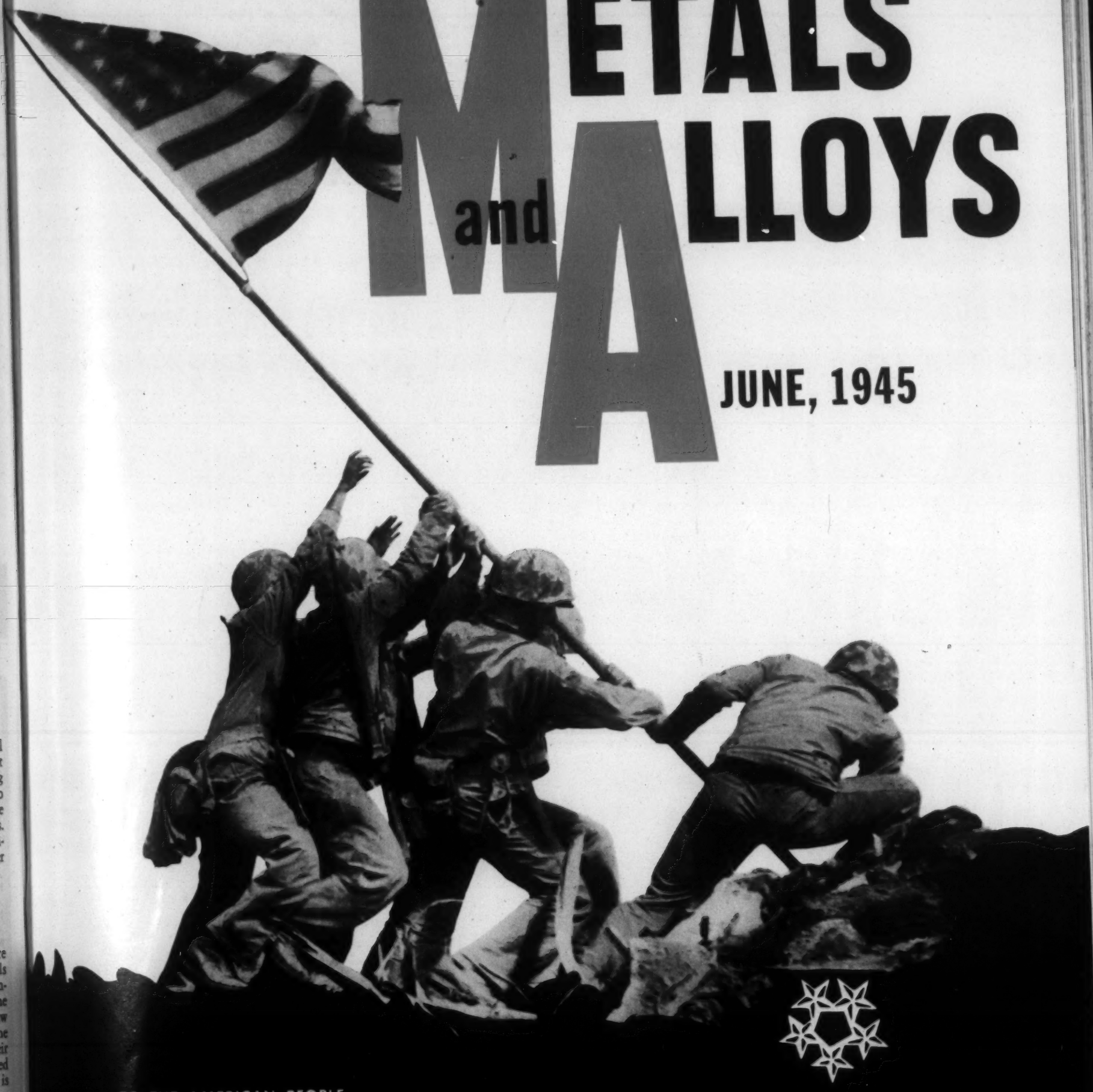
METALS and ALLOYS

JUNE, 1945



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JUNE, 1945

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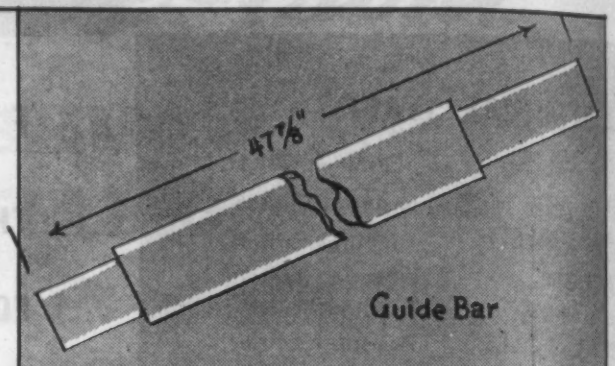
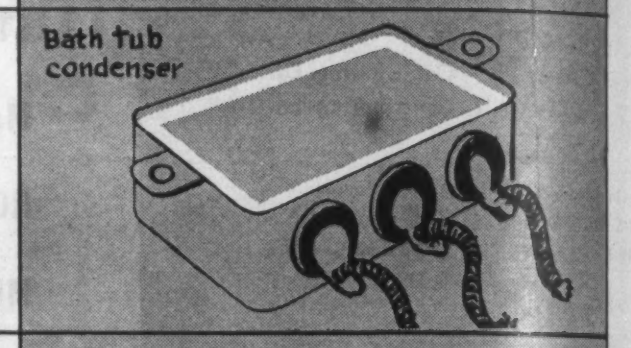
INDUCTION HEATING CORPORATION
NEW YORK CITY

Case Histories: Hardening & Brazing Applications — Data Sheet No. 14

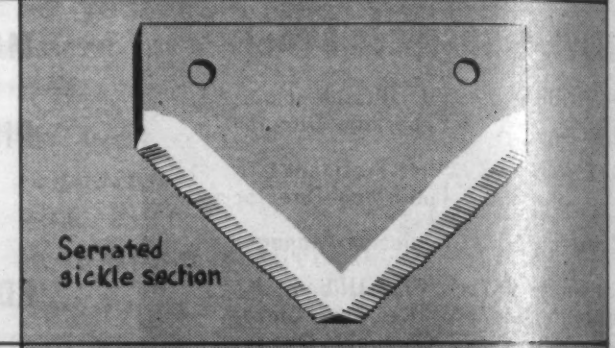
Job: To surface harden guide bar.
Material: SAE 1045.
Production: 10″ in 60 seconds.
Equipment: Model 2200 Thermonic Induction Generator Three turn coil.
Remarks: The Guide Bar 2″ in diameter was heated progressively and spray quenched. R.C. 63-66 was obtained to a depth of 3/32″ to 1/64″.



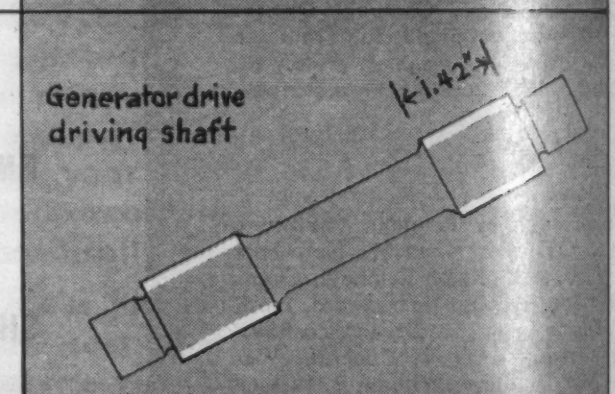
Job: To soft solder bath tub condenser.
Material: Copper cans.
Production: 40 every 60 seconds.
Equipment: One Thermonic No. 520 Induction Generator and one table with a conveyor set-up.
Remarks: .072″ soft solder was used to solder cover to can 1¾″ x 1″.



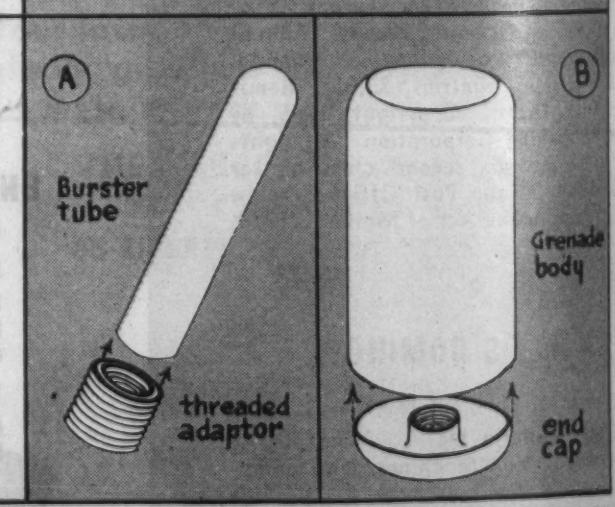
Job: To through harden the cutting edge of a serrated sickle section .070″ thick.
Material: Hi-carbon steel—JDM—1086.
Production: One every 5 seconds.
Equipment: One Thermonic No. 1070 Induction Generator and single position table.
Remarks: Part was dropped vertically into an oil bath. An R. C. 62-66 was obtained. Hardened area was 3/8″ to ½″ deep.



Job: To surface harden 2 bearing surfaces on generator drive driving shaft.
Material: AMS 6322.
Production: 1 Shaft every 15 seconds.
Equipment: One Thermonic No. 1070 Induction Generator and progressive fixture.
Remarks: The bearing surfaces are 1.42″ long—.935″ O.D. Part was heated progressively and oil spray quenched. An R. C. 52-55 was obtained. 3/32″ maximum penetration. Total length of shaft is 7 3/8″. Part was rotated at 44 rpm through the coil.



Job: (A) To silver braze a M15 grenade (burster tube assembly).
(B) To silver braze the "end cap" to the steel body of the M15 grenade.
Material: Steel.
Production: (A) 12 Burster tube assemblies in 15 seconds.
(B) 6 in 35 seconds.
Equipment: Two Thermonic No. 1070 Induction Generators and two 2 position tables.
Remarks: A 3/64″ silver alloy ring was used in brazing the tube to the threaded adaptor and a 1/16″ silver alloy ring was used in brazing the "end cap" to the body.



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EDITORIALS

Forthcoming "Bulletins" on Reconversion and Post-War Materials and Methods

With the end of the war in Europe, METALS AND ALLOYS is interrupting its regular program, so to speak, with a series of editorial bulletins on the engineering problems involved in reconversion of war-production equipment and in planning the materials and processes to be used for post-war products. These will be similar in size and comprehensiveness to our popular "Materials and Methods Manuals", but will concentrate on the special and now-timely reconversion and post-war theme.

This new series will be called "Reconversion Bulletins", and will appear every other month (alternating with the "Manuals"), starting in our July issue. The first bulletin will be "Reconversion (or Disposal) of Machinery and Equipment", and will present about 16 pages of information designed to help the engineer and manufacturer decide what to do with his war-production machine tools and other equipment, and how to go about selling it, storing it or reconverting them for peacetime production.

Subsequent Bulletins will cover "Materials for Post-War Products"—a presentation of new engineering materials and new uses of older materials, together with a directory of materials manufacturers; a similar treatment of "Parts and Production Methods for Post-War Products"; a fourth on "Modern Coatings and Finishes"; and a fifth and probably final Bulletin on "Modern Processing Methods and Equipment." The objective of each of these will be to bring engineers up-to-date on the materials, methods and applications that have been developed, evolved, improved or thrust into prominence during the war and which will have special interest to post-war product- and production-planners.

—The Editors

Another "Machine Age" Phase

A so-called "secret engineering weapon" has been the spotwelding of aluminum and magnesium alloys and stainless at the Willow Run plant of the Ford Motor Co. Spot, seam and roll welding machines have been applied to 100 assemblies in B-24 bombers, a technique that has saved 125 man-hours per airplane.

Now here is the point of this editorial—the welding teams are comprised of new employees who start spotwelding *the first day on the job.* Apparently not much skilled labor here! Moreover this is not an isolated instance. Throughout the war complicated techniques have been broken down into simple elements, or into jobs the unskilled can perform.

It is interesting to conjecture what this means for post-war industry. It might seem that the all-around skilled mechanics have passed their hey day—not yet as extinct as the dodo, but at first blush on their way out. One might surmise that only two types of workers will hereafter run a plant—the superbly skilled personnel and unskilled labor. In the first class will be the talented engineers, perhaps technically trained in schools, or the equivalent. They will be the ones who devise the simplified jobs. Their work may be a bit too advanced for ordinary "skilled labor" as we have known it. True, the "skilled labor"

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can serve as foremen and instructors—but will there be enough jobs of this kind for them?

This change, too, will affect the labor unions. Theoretically, the unions will have more reason to exist than ever before. Where a man is highly skilled he does not need the protection of a union, at least to the extent of the unskilled person.

Of course the skilled workman can go to lines of work that have not yet been broken down into simple units—such as die making and dressing, tool making, etc. Yet in time, won't these skilled functions, too, be simplified?

Apparently the dividing line between skilled and unskilled worker will grow sharper. There may be no need for "semi-skilled" workers. Perhaps the salvation of the present skilled worker is to improve himself more and climb into the skilled engineer class.

The entire subject is related to agitation on the part of labor throughout our machine age to go slow in perfecting labor-saving machinery, lest it bring about unemployment. Yet it can usually be proved in the light of many years' experience that machines create work in the long run, even though at times there are temporary dislocations.

It is a rule that stands the test of time that any technique or machine that produces more and with less effort is good for society and for the plant worker himself.

—H.A.K.

New Competitors for Tin in Cans

Metals for the canning industry are showing the effects of wartime development resulting from the tin shortage. Sheet steel dip-coated in tin was the pre-war standard material for this purpose. The war-created scarcity of tin brought out the electroplating process, with a subsequent heating to "flow" the tin and eliminate pinholes. Bonderized steel was found to be suitable for many packaging applications.

Aluminum cans have been used on a small scale, but seem to be too expensive to compete on a price basis, particularly since aluminum is not suited to fabrication on present equipment designed for tinplate. Soldering presents difficulties for the automatic machines.

A new competitor for tin is arising in the plastics field. The glyptals were developed as synthetics for the paint and lacquer industry and, because of great flexibility, were adapted for use in coating stock for containers. These resins are now being produced to meet a test in which the resin-coated sheet metal is bent back upon itself, flattened, then opened and bent back to the opposite side and flattened—all without showing any break in the film.

—K. R.

Die Castings vs. Screw Machine Products

It has long been known among production men that the die casting machine and the screw machine are among the highly efficient means for producing certain types of metal parts on a large quantity basis. But relatively few of these men and few designers are aware that certain types of parts commonly made by the screw machine can be produced more economically by die casting.

It is significant therefore to find an authority on screw machine products, W. G. Nord, U. S. Automatic Corp., Amherst, Ohio, writing in our January 1945 issue as follows:

"We [presumably meaning makers of screw machine products] must frankly admit that many of the parts that were previously made, and for that matter are now being made, on screw machines may be produced more economically as forgings, stampings, castings, die castings, molded plastics, etc., especially where large quantities are involved so that the cost of molds or dies are readily absorbed. . . ."

In so writing, Mr. Nord doubtless had in mind some of the shell parts that were formerly produced on screw machines but have more recently been converted to production by die casting, but there may well have been other parts of a similar nature, though for different uses, as there were many such, even before the war.

In informal comment on this matter, Mr. Herbert Chase recently suggested to us Mr. Nord may not have appreciated that most of the parts converted from screw machine products to die cast products require some machining, especially for flash removal and the chasing of threads. Such machining can often be done with high economy on an automatic screw machine, if it is fitted with a suitable feeding device; or on a chucking machine which is, in effect, a screw machine minus provisions for feeding bar stock. There is thus an opportunity for a close tie-up between the die caster and the screw machine operator (who may be a manufacturer who has a battery of screw machines or who may make screw machine products only for the trade).

Such a tieup might well enable the screw machine product plant to meet competition that could not be met otherwise. Many die casters would be glad to be rid of the machining operations while, under normal conditions, the screw machine plant might well profit by doing its end of the job, namely, the machine-work. Thus, advantages both ways.

A great disadvantage of the screw machine, from a competitive angle, is that it must often convert into chips as much or more metal than remains in the finished piece. On the other hand, the die casting wastes almost no metal, for it is produced so close to finished size and even the small amount of chips that result from light cuts can be returned directly to the melt with negligible loss.

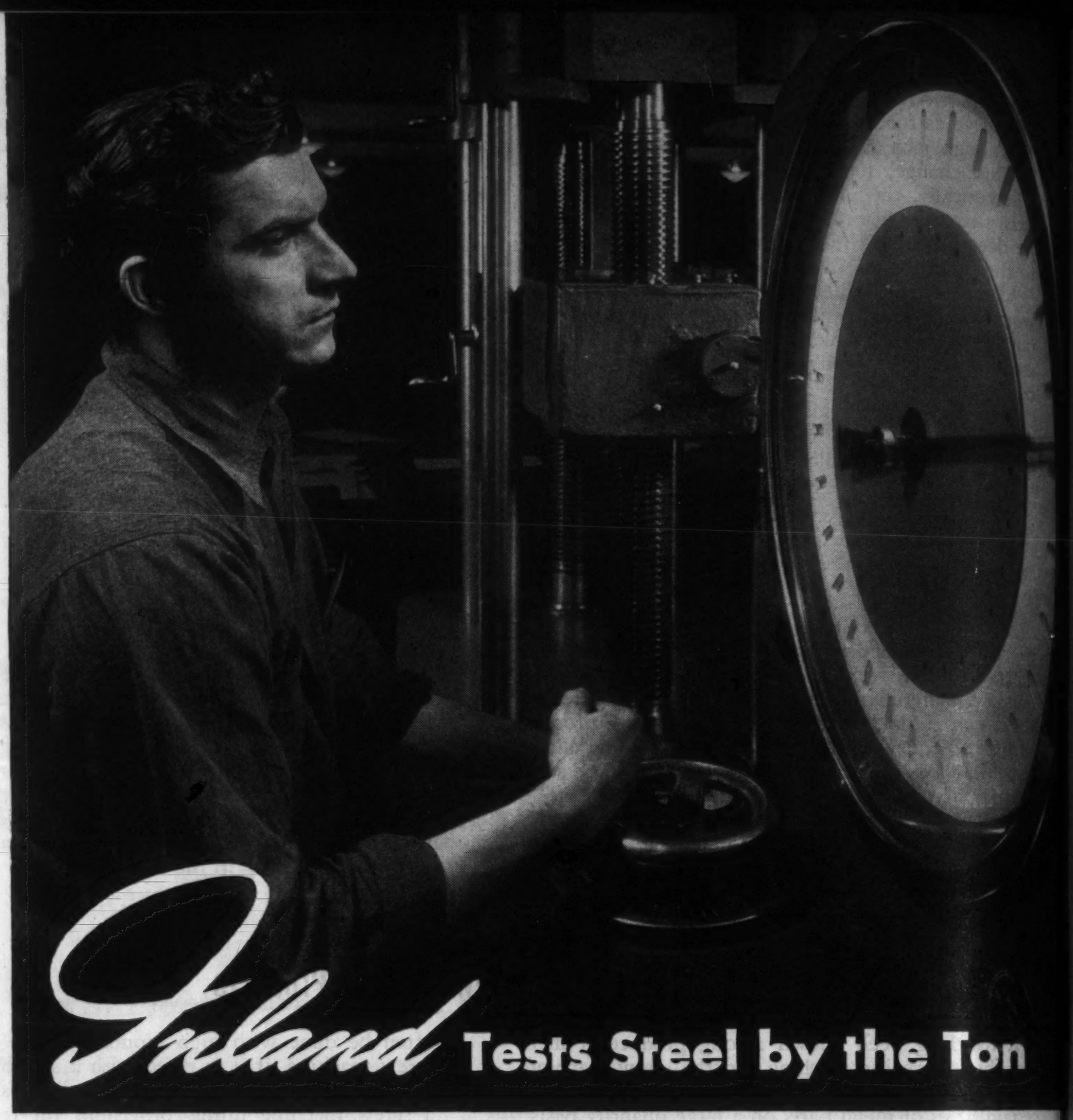
With a close working arrangement between the screw machine plant and the die casting plant, each could profit by the economies of its own equipment and should be able to turn out the finished product at minimum cost. Without such an arrangement, either the die caster or the screw machine operator may find themselves competing when each might be making the most of economies otherwise sacrificed.

—F.P.P.

Special duty trucks gather steel samples for the laboratory.

A truck is unloaded at the laboratory, and immediately starts another round trip.

Plate samples are punched to rough form, then milled. Others are sawed, turned, drilled, etc., as required.



Inland Tests Steel by the Ton

Operator determining physical properties on one of the many tensile testing machines in the Inland laboratory.

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Machine Tools and the Engineer

an Editorial

Because we believe so firmly in the leadership potential of the engineer we have often and loudly urged greater application of his talents and knowledge to solving the general industrial, economic or even sociological problems of the day. After each of these outbursts one of our older and wiser brethren usually suggests that the engineer is (in general) still economically or politically or socially illiterate and that his influence must for many years continue to be the indirect one resulting from the nature of his scientific and technical advances rather than the direct use of his abilities in public life or office.

But without arguing the point this time let's examine one of our currently greatest economic problems—the achievement of high-level post-war employment and thereby of post-war prosperity—and show how the engineer can make one outstanding though indirect contribution to its solution through his technical activities.

To secure this all-important high-level employment on which ultimate National well-being will depend, we must have active markets for the products of the employed. No such active markets will exist without the lowest possible prices for the products sold and this in turn can come only from lowest possible production costs per unit manufactured. A major method of lowering production costs (especially with wages likely to remain high) is to increase productivity or the output per worker. To increase productivity we use machines to the limit and then boost the output of each machine in every way possible.

The need for increased productivity should therefore be a major force compelling the maximum use of the war-built surplus machine tools (about whose post-war disposition and effect on the new-machine market so many people are now worrying) as well as the new machine tools being planned and developed by the machine tool manufacturers. Now how can the engineer help to achieve this maximum use of all the war-installed machine tools plus the new machines that the manufacturers hope to make and sell in the post-war years?

In the first place the engineer in the machine-tool plant—the machine tool designer and builder—can evolve and design new machines so far surpassing the old in productive capabilities, in convenience of setup, in mechanisms and controls, in versatility or adaptability to mass production requirements, in ability to use most efficiently modern cutting tool materials and lubricants, etc., as to render obsolete all the installed machines that are ten or more years old. In thus aggressively and imaginatively redesigning the machine tool he will not only increase the productivity of his customer's plant but will activate the market for his own industry—in itself an important segment of American manufacturing.

In the second place the engineer in the general product-fabricating plant—the machine-tool user—can redesign *his* products and re-plan *his* processes to use modern materials and modern fabricating methods, and especially to utilize all the productivity-increasing and cost-reducing features that the new machine tools will provide. In doing so he may force the "premature" obsolescence of some of his company's older machine tools but the net cost-saving can nonetheless be considerable and the overall effect of a nationwide campaign of product and production modernization on lowered costs and prices and higher sales volume—and therefore on ultimate prosperity—can be tremendous.

No matter how regarded, such a program—imaginative machine-tool engineering by the machine-tool builders, coupled and coordinated with modernized production engineering by the engineers who control the materials and methods of the product-fabricating industries in general—would be a strictly engineering contribution and is indeed a strictly engineering responsibility.

FRED P. PETERS

A Methods Article Not since "scientific management" invaded the domain of factory administration many years ago have the metal working industries seen so significant a development as the tidal wave of technology—the wholesale application of engineering principles and control in the processing of their materials and the fabrication of their products—that has engulfed them in the last 10 years. A fundamental transformation has occurred, and in this article Mr. Cady shows how and why it has affected metal-working's No. 1 production method—machining—and the selection of the equipment—the machine tools—to carry it out. This article and the editorial on the preceding page are the opening guns in a METALS AND ALLOYS campaign to aid the engineer in meeting these fuller responsibilities through better overall production planning, better machine tool selection, better machine tool design, better machine tool use and operation—in short, better engineering of that operation which more than any other can give this country the postwar productivity and prosperity we all so earnestly wish.

The Engineering Approach to Machine Tool Selection

by EDWIN LAIRD CADY

INDUSTRIAL MANAGEMENT OF TODAY has two distinct types of technical personnel: The engineer who can make overall plans and the technician who can operate processes, make tools, and set up and run machines. Each of these is known by many titles, the engineer" or "production engineer" or "process engineer" or "methods engineer" or just "engineer" and the technician "production supervisor" or "master mechanic" or "machine shop foreman."

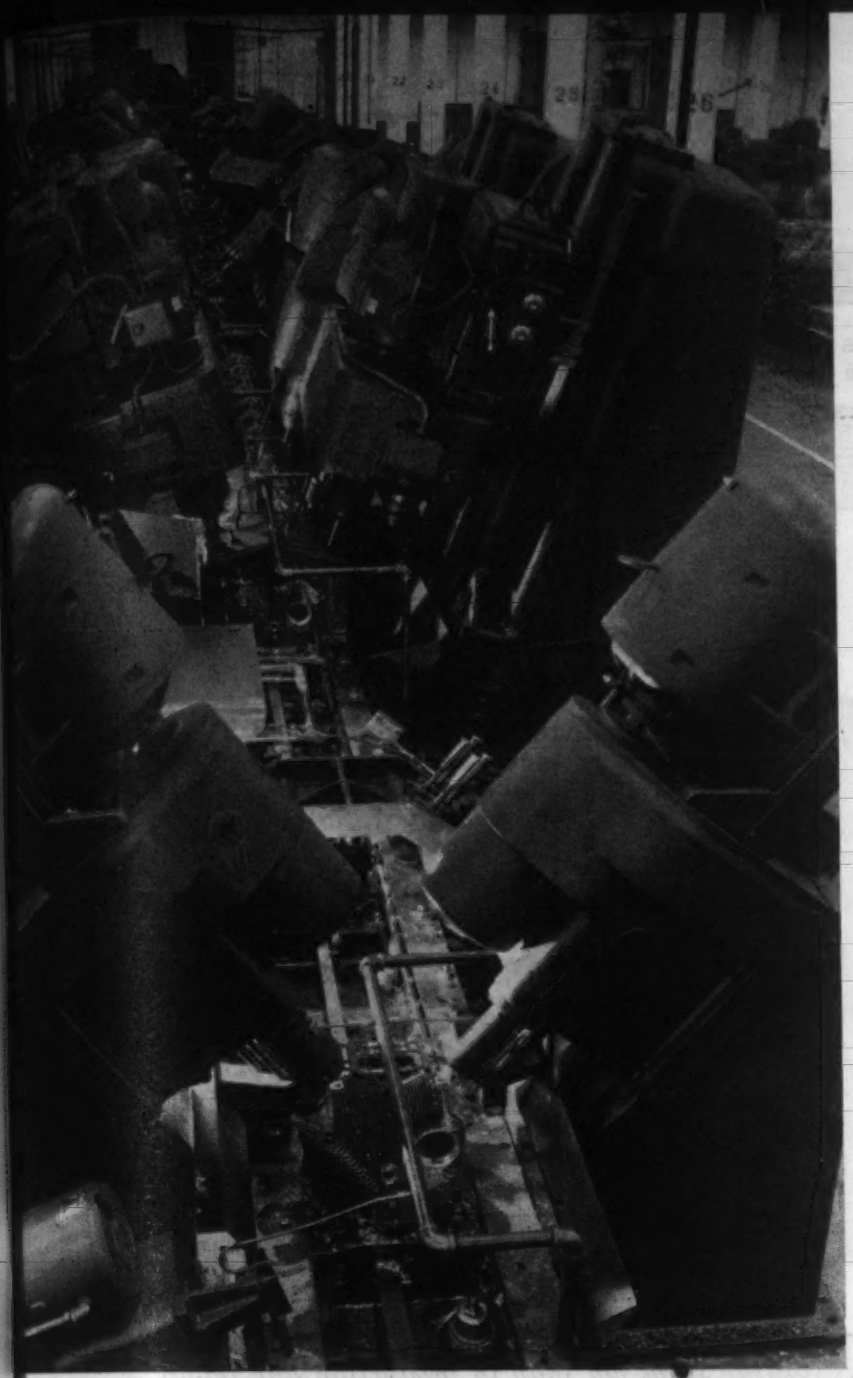
Names make no difference except for brevity and convenience. The point is that there is a well known and well defined "engineering approach" to management problems and an equally well defined "technician approach," and that the engineering approach has increased in importance until it now dominates the purchasing of machine tools.

There are many reasons why this dominance has come about. One of them is the change in the character of a "production unit." In the old days one lathe with its operator would be a production unit. The operator could set up his own machine, decide upon the proper depths of successive cuts to achieve a desired accuracy and finish, make his own tools and to a large extent handle his own materials. Naturally, any improvement in such a production unit consisted of a better lathe which the same operator could handle to better advantage. And this is the familiar technician's approach—the gradual improvement of existing processes.

In the modern scheme whole departments, whole buildings which house many departments, and even whole factories are operated as if they were single machine tools. The individual lathe is just as important as it ever was, but its tools are made by the tool making department and by designs laid down by production engineers or tool engineers, its setting-up may be by special set-up technicians and not by the operator, the cuts and their sequences are determined by methods engineers, its materials handling is under the direction of intra-plant traffic engineers, the inspection of its work is by inspection technicians and by methods laid down by testing engineers.

The operator used to vary his machining methods in accordance with variations in raw materials; now the raw materials are kept uniform by engineering methods. He once controlled his own lighting; now this is controlled for him by illumination engineers. He was responsible for the maintenance of his machine and often for its major repairs; now everything from simple oiling to complete overhaul is done by maintenance gangs under the direction of maintenance engineers.

Space for a machine tool once was allotted by the square foot, now it is more likely to be by the cubic foot including space overhead for materials handling, lighting, air conditioning and noise control. Space also is allotted within floors, under floors, within walls, within columns, under ceilings, within ceilings and above roofs. Here must go pipes for cutting oil and for compressed air, conduits for electrical power, electrical control mechanisms, motors, pads for vibration dampening. Flooring materials may be in island arrangements with one oil proof kind where the machine itself is to stand, a softer and more comfortable one beneath the feet of the operator, a soft one where heavy parts might drop or will rest during



The trend toward special-purpose machines requiring close collaboration between engineers of machine tool builders and users is exemplified in this 200-ft. long Greenlee automatic transfer machine that performs more than 70% of all the machining operations on Wright Cyclone cylinder heads. Courtesy: Wright Aeronautical Corp.

materials handling, a durable but noise absorbent well defined safety aisle for trucking, special easy access kinds where ducts and conduits are to run.

It is far easier to think of a factory building which has such features as being one gigantic machine of which the individual machines and processes are parts, than to consider it the mere housing for them. And as whole production processes are more and more thought of as if they were single machines—the engineering approach—the engineer has to be more and more in charge of the selecting of individual machines. Otherwise, the individual parts of the overall production process would not fit together.

Production Philosophies

Engineers must fit machine tools to the production philosophies of their employers. And very often two such schools of thought are contradictory to each other. Examples:

Mass Methods Rigidity vs. Job Shop Versatility: Machines bought for mass production methods often must sacrifice adaptability in order to gain high speeds on limited ranges of operations—they approach the "single purpose machine" class. Machines bought for adaptabilities to quick changeovers from product to product, usually are slower for single operations. Management engineers must make this choice.

Full Automatic vs. Secondary Operation Production: When one machine is to turn out completely finished parts, the production lots must be high and the set-up and tooling costs must be high enough to produce the finishes and accuracies desired. But when the initial machine does only part of the job then the secondary machines can make minor changes in the basic part and therefore permit the production runs of any one finished form to be lower, and the secondary machines can take care of much of the accuracy and the finish thus reducing set up costs of the initial machine.

There are many other philosophies of production. The engineer works with these in his daily life while the technician is improving the performances of the details of production. Therefore the engineer always has the responsibility for deciding what machine tools will best promote his company's philosophy of production. And since one department may be held to a different philosophy than another—the exigencies of marketing the company's product usually decide this—the engineer may have to decide between the features of "apparently equal" machine tools in accordance with the departments in which they are to be used.

Competition of Processes

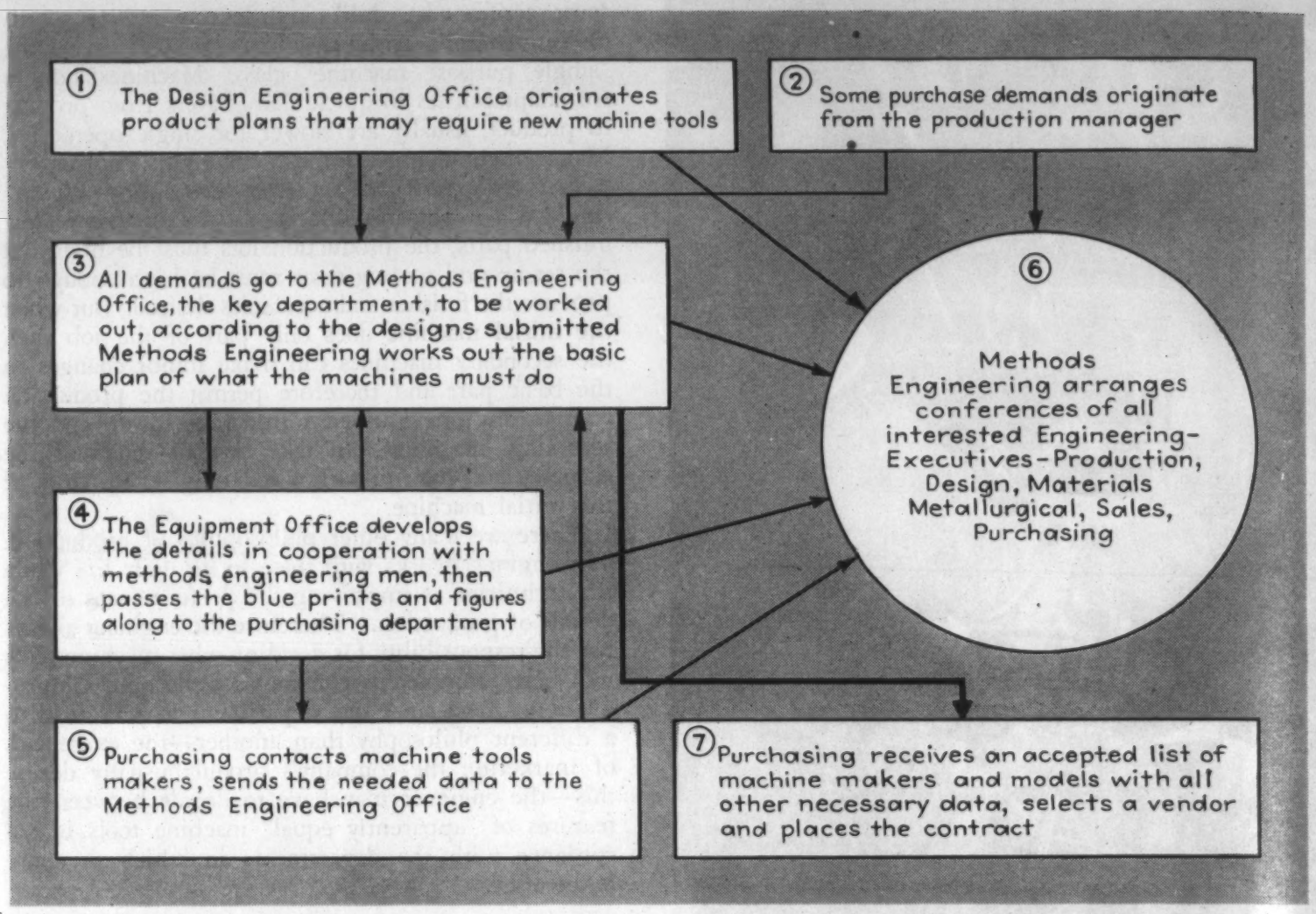
Whole processes compete with each other for the privilege of entering into the production of nearly all products. Examples:

Machined Castings vs. Welded Formed Shapes: For the castings the engineer must select heavy lathes, planers, shapers, millers. For the welded shapes he needs punch presses, shears, brakes, welders. And having selected a whole production process he must fit his materials handling, assembly methods and finishing methods to it.

Die Castings vs. Plastics: The engineer is likely to need heavier finishing and secondary operation machines for die castings than for plastics.

Machine Hard Materials vs. Anneal, Machine, then Re-Harden: Stronger machine tools, costlier tool materials and cutting oils, more power and slower production speeds may be needed for machining hard, tough materials. Two or more heat-treating operations with consequent pickling and cleaning may be needed if the materials are annealed and re-hardened, but the machine tools may be less costly, lighter and faster operating. In either case whole chains of preceding and following operations, as well as materials-handling ones, will be affected.

No matter what production process he chooses the engineer still must fit individual machine tools and other equipment to the production philosophies of his company. And if that philosophy be changing—as it so often is—then he has to select machine tools



How a large manufacturer of machinery reaches decisions concerning new machine tools, showing the key position of the "methods engineer." This company is shifting from job shop to production line set-up.

which will promote the new trend while being compatible with the existing conditions in the shop.

Financial Considerations

Matters of depreciation, obsolescence, inventory and maintenance must be considered by the engineer when selecting machine tools. And for these his company usually has policies which the machine tools must fit.

Depreciation, traditionally, is in percent of original cost (commonly 20%) a year. But in many cases a machine tool operates only for a short production season each year, and depreciation is on a "per production hour" or even "per 1000 pieces machined" basis.

If depreciation is on a yearly or hourly basis then a less costly machine will have lower depreciation burden to carry, but if depreciation is on a "per piece" basis then a more costly but faster producing machine may depreciate itself in less time and thus return its original cost more quickly for re-investment in other equipment. The engineer must decide between the two machines in the light of his company's financial policies.

Obsolescence of a machine tool may be predicted on the basis of expected improvements in the machine tool building art, or of expected changes in the user's product, or of probable changes in available raw materials, or of changes in the company's production philosophies. Like depreciation, obsolescence may be on either a "time" or a "per piece" basis and the engineer must choose his machine tools accordingly—but otherwise than that the depreciation and the obsolescence factors are not necessarily in parallel. A machine tool can be fully depreciated before it is obsolete, or obsoleted before it has lived out its full depreciation period.

If the company policy calls for large inventories of semi-finished parts then the desired production rate is likely to be slow but steady, with machine tools selected for simplicity of tooling, ease of change-over, slow depreciation and low maintenance costs. If the company believes in low inventories of everything then the engineer prefers highest speed machines, complex tools, rapid obsolescence if not rapid depreciation with perhaps higher maintenance—anything to turn raw materials inventory into finished goods as rapidly as possible.

Maintenance costs and troubles are directly related to depreciation and obsolescence periods. Modern machine tools will run long times without high

maintenance bills, but the longer any machine tool runs the closer it comes to the high maintenance cost period of its life. If obsolescence is to be rapid then the engineer may select a lighter, less costly, less durable machine. But if depreciation and obsolescence periods are to be long then the costlier, overcapacitied, more rugged machine tool may be preferred.

The estimation of probable maintenance is an engineering function. Modern machine tools are highly complex as well as extremely accurate and durable. The parts which are most likely to wear or to fail (there are no "one hoss shay" machine tools) must be studied. The probable failure areas may vary for different applications; bearings may fail first if there are shock loads on the machine tool, gears if there are vibrational loads. Often a slight modification of the standard construction, such as the use of heavier and tougher gears, will be indicated.

Calculating the effects of machine tool wear upon the secondary uses of the machine is an engineering problem. If the machine simply becomes less accurate it may be transferred from a high accuracy production department to a lower accuracy one. If the company's production policies are those of versatility rather than of highest production the worn machine may be transferred to special duty, to stand-by service or to operations which do not involve the functioning of its badly worn parts. The machine tool rebuilding program of many a large company is an engineering function in itself.

Design and Production Related

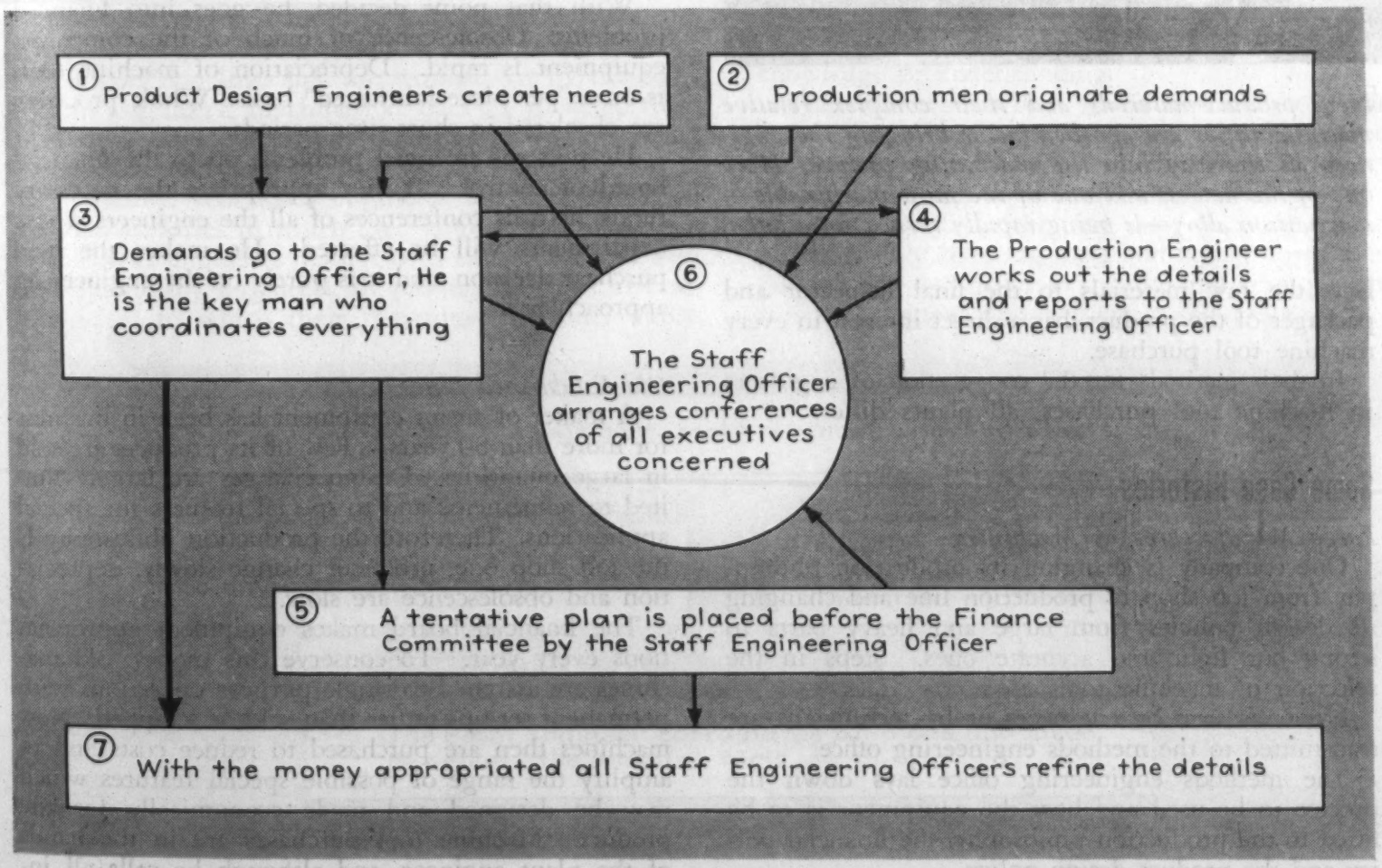
Machine tools establish what the product designer can do. They can restrict his work and they can provide him with new opportunities. It is useless for him to design anything which his company's machine tools—or the ones his company is willing to purchase—cannot make or which his company cannot buy outside. Therefore he has a strong voice in the selection of machine tools by his own company, and often in the selection of those used by suppliers of parts and subassemblies to his company.

Manufacturers have product design policies. The policy may be to make small and light parts in which strength is obtained by careful selection of raw materials, high accuracies of dimensions and surfaces, rigidly controlled heat treatments and close attention to the avoidance of stress concentrations. Or the need for such care may be avoided by designing larger and heavier parts.

Methods and process engineers then must select machine tools which will carry out the ideas of the designer while observing the design policies of the company.

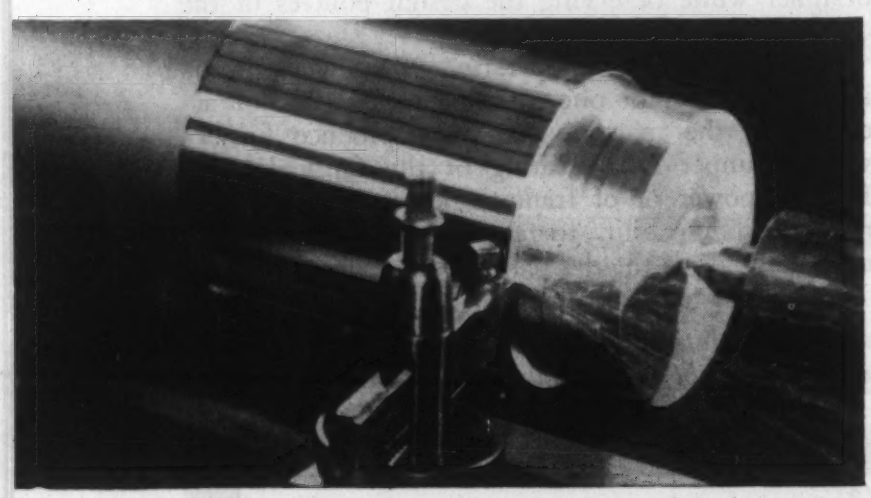
This calls for the cooperation of many engineers in the selection of one machine tool. Lack of accuracy in the machine tool may produce finishes which hamper heat treating of the finished parts. Lack of power or of frame rigidity can reduce the machine tool's ability to fabricate the desired tough raw materials at the desired speeds. Lack of versatil-

These steps in the selection and purchase of machine tools by an automotive and aviation products maker, largely centering around a "staff" or executive engineer, demonstrate the mass production philosophy.



ity can prevent the production of the needed intricate contours which have highly accurate relationships to each other as well as highly accurate dimensions and surfaces. Or, when the highest accuracy is avoided by making parts larger, the machine of highest accuracy may lack the ruggedness for hogging out the parts.

The observance of all these factors in machine tool selection calls for the cooperative effort of large numbers of engineers. Such is the intelligence of modern machine tool builders that the engineers can find machine tools to fit any production philosophies, process families, financial policies and product design needs. But the engineer who directs any department which will be affected by the performance of a machine tool must know exactly what that machine will do for his department—he must be sure that it will increase the ability of his department to function rather than adding to his troubles. This means that every engineer, from the man who selects the raw materials to the final inspector and packager of the product, has a direct interest in every machine tool purchase.



New product-materials and their complex relative machinabilities are another factor bringing the engineer all the way into the machining picture. Here one of the newest and one of the most machinable—magnesium alloy—is being rapidly turned on a lathe.

In their methods for the cooperation of engineers in machine tool purchases, all plants differ.

Some Case Histories

Large Manufacturer of Machinery

One company is changing its production philosophy from job shop to production line and changing its design policies from large and heavy parts to strong but light and accurate ones. Steps in the selection of machine tools are:

Needs as seen by engineers or by technicians are transmitted to the methods engineering office.

The methods engineering office lays down the process to be used and how the equipment is to be fitted to the production philosophy, the financial policy and the product design policy.

The equipment office designates the exact performance desired in terms of raw materials to be fabricated, pieces per hour, finishes, accuracies, effects upon heat treatment and inspection operations. It goes on into work cleaning processes, materials handling, probable inventories of finished parts, depreciation and obsolescence allowances and calculations, blue prints of parts to be made and of space allotted to the machine.

The machine tools purchasing engineer forwards descriptions of competing machine tools which will fit the conditions.

The methods engineer takes over, arranges conferences of all engineers whose work will be affected by the machine tool in question, and by this means refines the list of possible selections until the machines which are certain to be suitable have been indicated.

From this indicated list the purchasing engineer places the contract.

An Automotive and Aviation Products Maker

Production philosophy is geared to the mass production methods common to the industries which the company serves. But for those rapidly progressing industries the product designs must be changed continually. And from those changes come most demands for new machine tools.

All demands for new machine tools come to the staff engineer (official title: "Engineering Assistant to the Vice President").

The company continually is installing whole new production processes. The staff engineer must first decide whether the new product will fit an existing production process or a new process must be installed.

With that point decided, he goes into financial problems. Obsolescence of much of the company's equipment is rapid. Depreciation of machine tools is on a "per piece fabricated" basis. Whole processes are obsoleted in short time periods.

He puts the financial problems up to the financial board of control. If they appropriate the necessary funds, he calls conferences of all the engineers whose departments will be affected. He makes the final purchase decision, and it is purely on the engineering approach basis.

Old Established Lines

A maker of steam equipment has been in business for more than 80 years. Few of its products are sold in large quantities. Design changes are largely limited to refinements and to special features for special applications. Therefore the production philosophy is the job shop one, processes change slowly, depreciation and obsolescence are slow.

The financial board makes equipment appropriations every year. To conserve this money, old machines are assigned to single purpose operations with permanent set-ups rather than sold or scrapped. New machines then are purchased to reduce costs and to amplify the range of possible special features which may be designed and made economically for the product. Machine tool purchases are in the hands of the plant engineer, and although he calls all interested technicians into conference the final selection is wholly by the engineering approach.

Customers' Engineers Take Part

A machine parts maker has two distinct lines of products: Special for individual large customers' requirements, and standard for sale through hardware distribution channels.

When selecting machine tools for the special lines, methods or production engineers of the company talk with methods or production engineers of customers, the sales engineers acting as coordinators. By this means the customers are made sure that the company not only can make the desired parts at the desired prices but also can accommodate itself to probable design changes.

Methods engineers of the standard lines department also work on the selections of machine tools for the special lines, since many of these tools will find their way into the standards production line after being obsoleted by the special products department. The special lines machine tools which can never be used by the standards department, must be depreciated 100% during their production runs on the parts for which they originally were bought.

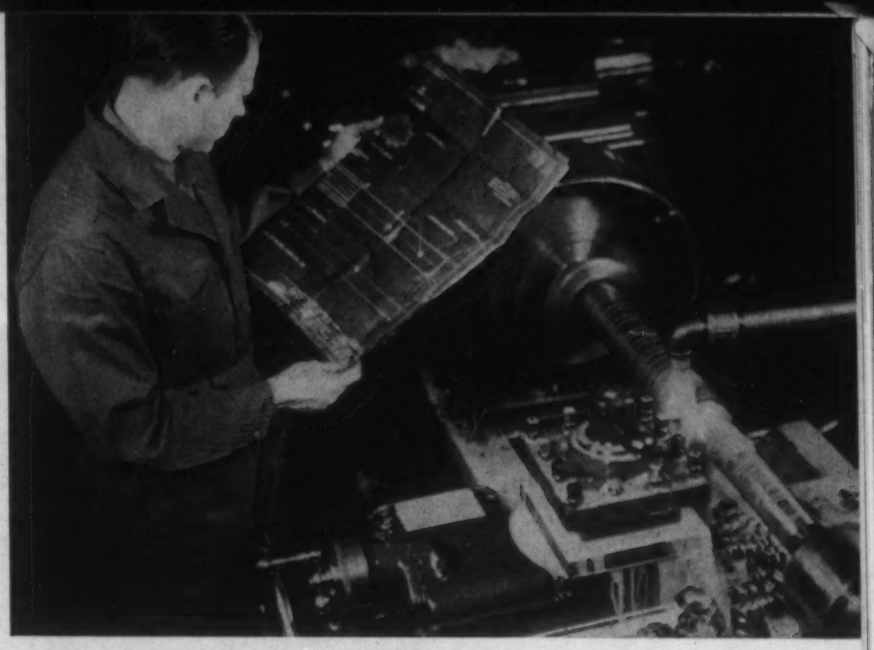
The standards department engineers also choose their own machine tools in accordance with the entire list of engineering approach factors. And the net effect is that many engineers employed by many companies work together to find for this company the best possible machine tools.

Committees of Sales Engineers

An aircraft company has as its most common machine tool purchase problem the complete installation of new production lines. Production philosophies are talked-of as if they were strictly of the mass production variety, but actually job shop philosophies and methods must be followed in departments where changes in the product are frequent.

Production lines first are worked out by the company engineers. Machine tool data are gathered from all sources. Comparisons of machines and processes are made and a rough plan is laid down.

Machine tool sales engineers are then flown in from the cities in which their companies are located. The sales engineers discuss with each other and with the company engineers all production steps and sequences to which their individual machines apply.



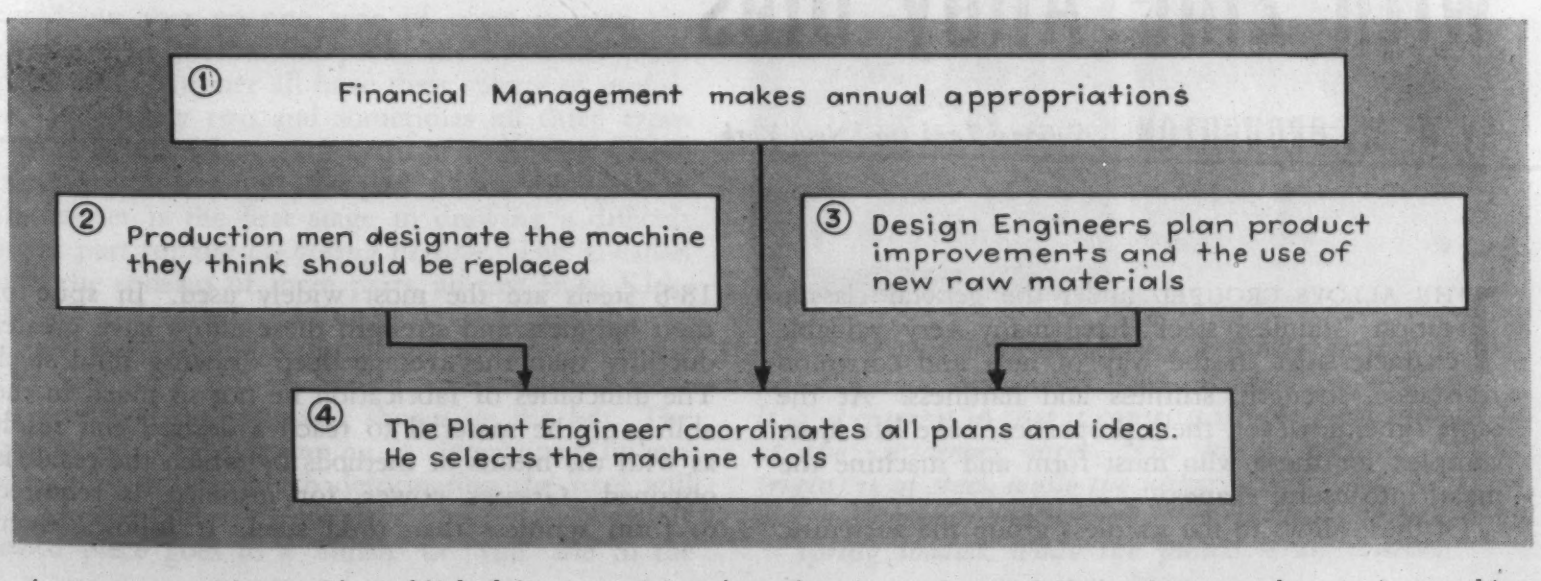
New cutting tool materials have revolutionized much machining and improved its engineering level. This picture of a turning operation using tungsten carbide tools shows as well how the shadow of the design engineer falls across every machining operation. Courtesy: Carboloy Co.

Methods and machines are worked out part by part, battery by battery, process by process and finally shop by shop. A completely coordinated and efficiently operating set-up is quickly laid down by the combined application of engineering minds.

Conclusion

The engineering approach is dominating the selection of machine tools in all kinds of businesses. This does not mean that the technician—the man who runs processes and continually makes direct improvements in their details—no longer has any value. The fact is, his job is bigger than it ever was. With changes coming as rapidly as they do today, the technician has more new things to learn, more opportunities to make direct improvements, more responsibilities for preventing the abuse of complex machines of which his machine operators have little knowledge or understanding.

The engineer has been raised to his authority and responsibility in the purchasing of machine tools by the very rapidity with which modern industrial progress is being made and industrial complexity is being increased. In the long run, of course, the engineer is only selecting tools and laying down methods for the technician to operate and improve. But it is the engineer who is doing the selecting.



A company with an old-established line requiring few changes in design follows this procedure in its machine tool selection, with the "plant engineer" the dominant factor.

A Materials-and-Methods Article Once considered as strictly "temporary" or short run dies, zinc alloy dies have now established themselves as permanent tooling for many sheet metal forming jobs and are extending their applications to several new fields. This 2-in-1 article presents a description by Mr. Broughton of advanced practice in using zinc alloy dies on stainless steel parts at Solar Aircraft plus a review by the editors of the general characteristics and uses of these inexpensive but durable die materials.

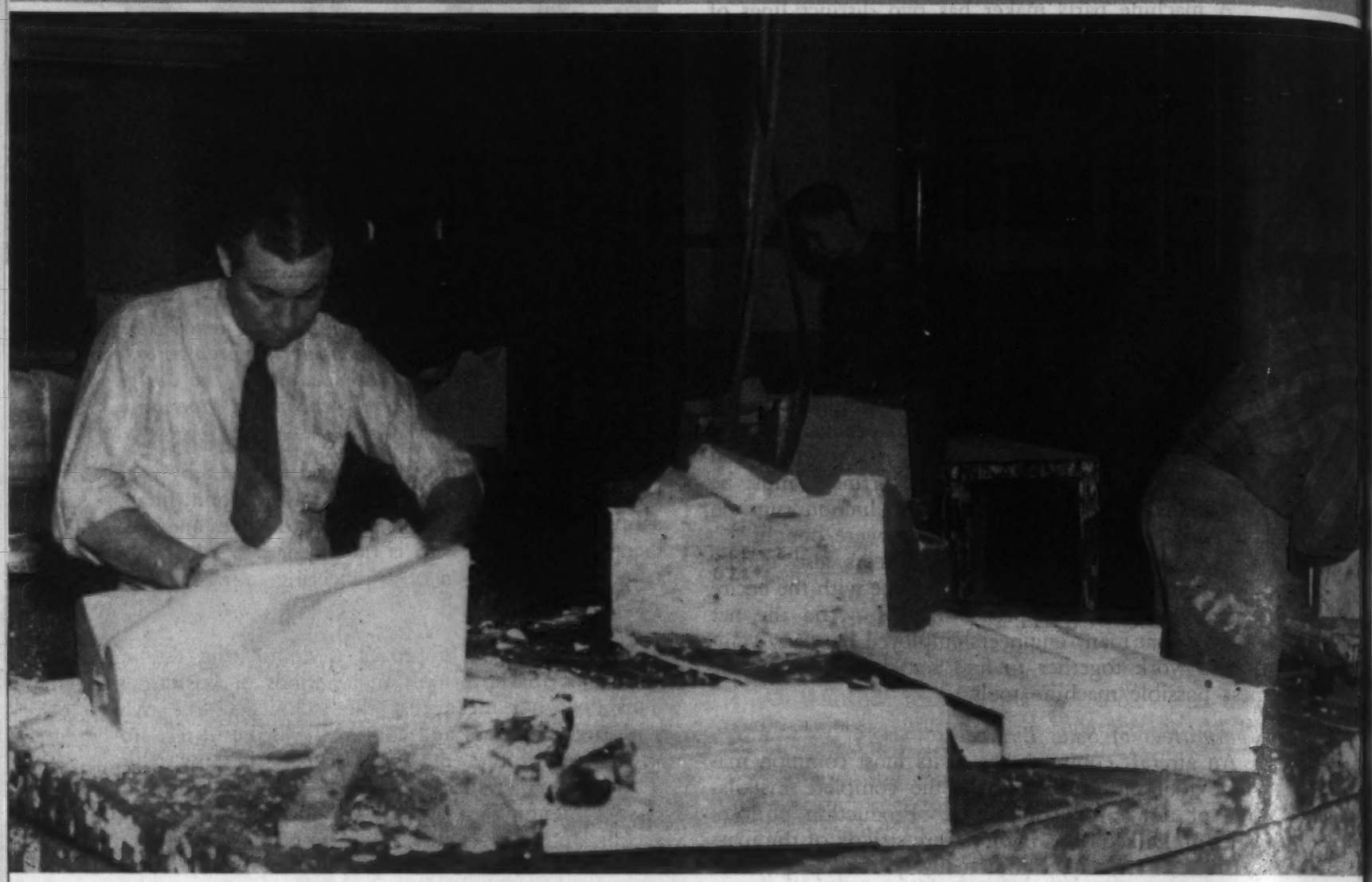


Fig. 1. A portion of the pattern shop. Plaster patterns have proven to be cheaper and faster to produce than wood patterns of the same degree of accuracy. If properly stored they will not warp or distort.

Forming Stainless Steel with Zinc Alloy Dies

by **W. W. BROUGHTON** *National Lead Co., New York*

THE ALLOYS GROUPED under the general classification "stainless steel" have many very valuable characteristics in the way of heat and corrosion resistance, strength, stiffness and hardness. At the same time, however, these properties make life more complex for those who must form and machine the metal into useful shapes.

Of these alloys in the stainless group the austenitic 18-8 steels are the most widely used. In spite of their hardness and strength these alloys have greater ductility than the average deep drawing mild steel. The difficulties of fabrication lie not so much in the ability of the material to reach a desired end result as with the means or methods by which the result is obtained. Greater power, for instance, is required to form stainless than mild steel. It follows, then,

when greater power is used that die design, gage and surface condition of the sheet, and effectiveness of lubricants are critical factors affecting forming operations. If zinc alloy dies are used in these operations any pick-up of zinc from them must be removed by acid pickling or the steel becomes brittle upon being subjected to elevated temperatures.

Austenitic 18-8 stainless steels are the alloys from which most aircraft engine exhaust manifolds have been made, and because of the restrictions imposed by functional requirements, space limitations, air flow (cooling without excessive air resistance) and other special conditions, the shapes of the stampings that form the manifolds are varied and complicated.

In spite of the conditions which make difficult the means by which stainless is fabricated, Solar Aircraft Company of San Diego and Des Moines rarely works any material not in the "stainless" group, and specializes in exhaust manifolds and jet engine components.

Originally engaged in building a practical and sturdy transport plane, Solar decided that the development and production of better manifolds presented a more profitable field of endeavor. That their decision was a wise one is witnessed by the fact that their sales have climbed from $84,000 in 1934 to $28,000,000 in 1944. The production indicated by the latter figure represents a very substantial proportion of all such manifolds made in the United States during that year.

In visiting the orderly, well lighted plant at Des Moines it was observed that almost all the dies used are made of Kirksite "A," a zinc-copper-aluminum alloy having physical properties far below those of the steel being formed. Long runs of heavy gage stampings are obtained on dies made in an average of from two to three man hours at low cost. Castings for the dies are made within a few feet of the presses and because of accuracy in pattern work and careful foundry practice their dimensions, as removed from the sand molds, are within 1/64 in. per foot of desired size and shape.

How The Dies Are Used

Some of the ingenious methods used at this plant will, we believe, be of interest. First of all, let it be pointed out that no one type of press is used exclusively. The mechanical press, the hydraulic press and the drop-hammer all have their sphere of usefulness. Frequently two and sometimes all three types are used in the fabricating cycle of a difficult shape.

Examine for example the part shown in Figure 8. This die set is the first stage in drawing a difficult exhaust part for the *Lightning Fighter*. The so-called starter die consists of three parts, all cast from Kirksite "A" and called, reading down, the punch, the pressure pad (or pinch ring) and the die. This die set is used on a 200-ton mechanical press and from it is produced the stamping shown on the left. The exact shape of the stamping is determined by experience as to how much deformation the steel will take without failure. Now after annealing, the partly formed piece goes to a "finish" or "full" die in the drop hammer where one blow is usually sufficient to produce the desired final shape shown at the right. This sequence of operations has the following advantages.

1. The cost of preparing the patterns for the starter die is low.
2. Wear on this die set is unimportant because it will be "restruck" and sharpened as to detail in the "full" die.
3. Since the "full" or "finish" die does not have much work to do to bring the part to its final shape, wear will not be rapid and the greater cost of accurate patterns is spread over a large number of finished pieces.

Many deep drawn parts are produced on the drop hammer alone with a single punch and die of Kirksite by means of an ingenious method of limiting the depth of draw.

After the die is set up in the hammer ready to operate, a layer of antimonial lead is poured over the surface of the die, using a small ladle and allowing the lead alloy to freeze immediately so as to build up a pad which is thicker in the deepest points in the die cavity than in the shallow points. The original pad of lead alloy is stripped from the die and replaced by a second, thinner pad which allows the steel to be drawn somewhat deeper.

After all the parts have been struck they are run through the Kirksite die with no lead pad, giving the part its final form. Some parts require several redraws, others just one intermediate stage. Operators soon become skillful at judging the appropriate thickness and distribution of the lead alloy.

Making the Dies and Patterns

The technique of producing Kirksite forming dies at Solar's Des Moines plant differs in many ways from the methods used in most aircraft factories. Instead of making a single plaster pattern for either the punch or the die and producing a Kirksite dupli-

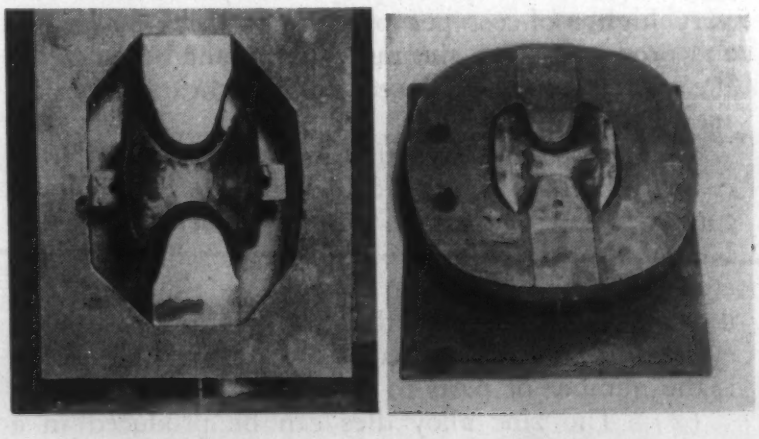


Fig. 2. The die for producing a saddle patch for a super-charger nozzle box used on the P-47 airplane. It is of interest in that it consists of four parts instead of the customary three. The lower pressure pad (right) is of steel, while the upper pressure pad (left) and both punch and die are all Kirksite. The pad is spring loaded, while the punch is air loaded.

cate in sand, grinding it to desired contour and using it as part of the mold in which the mating part is cast, Solar makes separate plaster patterns for each member of the die set, allowing for metal thickness between punch and die and also between punch and pressure pad. These patterns are carefully checked before being sent to the foundry.

From these accurate patterns castings are produced which can usually be sent direct to the press room for trial. The shape of the trial stamping determines whether or not fitting is required on the dies. If the shape of the stamping is found to be in error, corrections are often made on the die without removing it from the press, but if major changes are required, the die must be removed to an electrically operated fitting press so as not to interfere with production.

The finisher die pattern is always made first and if it is found that the stainless steel cannot be formed to its final desired shape using only the final die, stage dies are produced.

Press and Blanking Dies

The use of Kirksite forming tools in some operations utilizing punch presses has proven satisfactory and they are used in place of more expensive steel die sets wherever possible. Since the cost is low it is customary to make more than one die set when parts are needed in quantity. When the run is finished the Kirksite can be economically recovered by remelting for use again in the casting of new dies.

Although Kirksite "A" in sheet form is used by many stampers for blanking purposes, it has been found impractical to use this form of the alloy at Solar for blanking steel heavier than 0.015 in. thickness because of the physical properties of the materials used. Here all blanking is done with tools made from the finest alloy steels. Flanges up to ⅜ in. thick are being blanked at a high production rate and a low tool cost per part even though the width of flange must be less than its thickness, a condition that is always avoided by experienced press-tool makers as far as possible.

Solar has made an extensive study of all existing types of forming dies and has found that the combination of properties obtainable in Kirksite make possible high quality of product at low tooling cost. They propose to continue the use of Kirksite in post-war work and to expand their field of activity into every industry that uses heat and corrosion resisting alloys. Judging by the reputation they now enjoy in the aircraft field there is little doubt but that they will become a major factor in the fabrication of stainless steel for post-war uses.

General Properties and Uses of Zinc Alloy Dies

by The Editors

The advantages of zinc alloy dies over steel dies for production applications in general are reported to be as follows:

(1) The zinc-base dies are much less expensive. Steel dies are competitively uneconomical for relatively short-run work because the combination of their higher cost and the small-lot jobs results in a very high tool-cost per part. Obviously the shorter the production run the more important becomes the die cost per unit produced, so that cheaper dies are increasingly attractive.

As to cost—although the zinc alloy in ingot form costs more than the steel or cast iron in raw-material form, the cost of the finished die is much less for the Kirksite. Labor to make the die, machining costs, etc. are enough lower for the zinc alloy dies to make them cheaper *to produce* than steel or iron dies. What eventually controls the economy of the application is the number of parts to be made with a given die.

(2) The zinc alloy dies can be produced in a matter of hours, as against days for steel dies. This means production of a part can be started that much sooner, or that frequent changes in design or experimental production can be accomplished without prohibitive delays. In the reconversion, retooling and product-experimenting period that lies just ahead this last may loom as a major factor in smart research-engineering. Also, minor changes can be made directly on the zinc alloy die with a welding torch, when

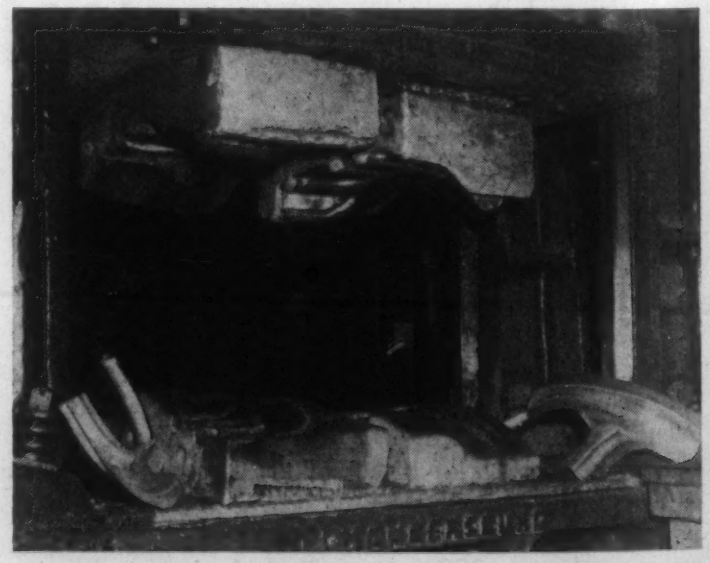


Fig. 3. Here are two Kirksite dies producing C-46 manifold parts from stainless steel of 0.050 in. thickness. Between 8,000 and 10,000 of these parts have been made on these original dies.

such changes are indicated by design modifications or for experimental reasons.

(3) The skilled but scarce diemakers required for making steel dies (blanking dies, for example) are not needed in the manufacture of zinc alloy dies, nor is as much critical machining required to finish the cast dies to close dimensional tolerances.

Other advantages of importance are

(4) The accuracy of casting that is possible with zinc alloys, often obviating machining of the cast die;

(5) The elimination of die scratches on the work by virtue of the zinc alloy's softness; and

(6) The reclamation value of the zinc alloy, for it is almost 100% re-usable by simply remelting under proper conditions.

The zinc alloy dies are made either as sand castings, plaster-mold castings or rolled sheet, depending on the purpose. Most soft alloy stamping, forming and drawing dies are cast, usually in sand; dies for certain plastics-molding operations—a growing use for

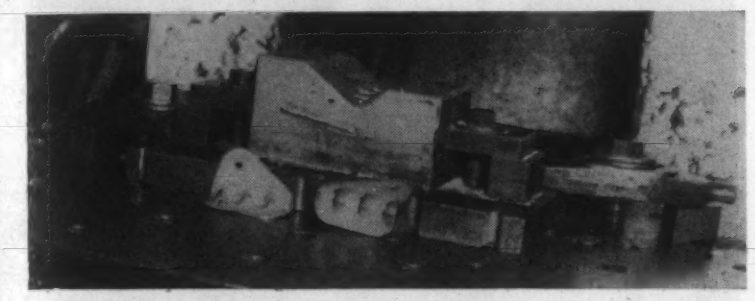


Fig. 4. The beaded clip die shown in operating position in a punch press has produced 8,000 perfect parts of 0.078 in. stainless steel. The part is a bracket used in quantity on the C-46 transport.

Kirksite—are cast in plaster molds, as are some stamping dies; dies made from rolled zinc alloy sheets are used for many blanking, forming and trimming jobs.

The forming machinery on which the zinc alloy dies can be and are being used includes rope and air drop hammers, hydraulic presses and brakes, and mechanical presses of toggle, crank and double-acting types. They are used with or without pressure rings or binders made either of the zinc alloy die material or of iron. The use of Kirksite "A" dies for punch press operations is one of the most recent developments (of which more later).

Punches used with cast zinc alloy dies may be made of the zinc alloy itself, of antimonial lead, of cast plastic, of hydrolized woods like Masonite, or of rubber. Often the punch is made by casting the punch material into the cavity of the Kirksite die. Rolled Kirksite dies for blanking are used in conjunction with steel punches, the clearance between die and punch being *zero*, so that the die will "flow" toward the punch and keep the cutting edge honed and self-healing.

Fields of Use

Broadly speaking the zinc alloy dies are regarded as low-cost dies useful for moderate production runs. They cannot be expected to replace steel or cast iron dies on all or even most of their established applications. The accompanying table indicates some successful Kirksite "A" applications and the number of parts either involved in the lot or the number made before die failure. These are all of an "extreme" nature showing either the thickest gages, or the longest runs made with zinc alloy dies. It has occasionally been found more economical to use up several zinc alloy dies on one job than to employ one steel die for the whole order.

Operation	*Material*	*Gage*	*Shape*	*No. of parts or blanks*
Forming	Armor plate	¼ in.	2-ft. spher. radius	several hundred
	Stainless steel	0.091 in.	2.5 in. rect. cup	400
	Stainless steel	0.038 in.	X-exhaust manifold	2,800
	Body stock steel	0.089 in.	3-in. draw	1,200
	Body stock steel	0.037 in.	3-in. bends	18,000
Blanking	Stainless steel	up to 0.050 in.	—	100
	Body stock steel	0.062 in.	—	1,800
	Duralumin	0.032 in.	—	30,000
	Formica	0.062 in.	—	10,000

For Molding Plastics and Rubber

A growing application that will certainly carry zinc alloy dies far beyond the confines of aircraft manufacturing is their use for molding plastics and rubber. Kirksite molds for both compression and injection molding are now used in several plants, with mold-life results varying from job to job.

For example one company has produced 600,000 injection-molded plastic telescope rings from a 4-cavity die made entirely of zinc alloy except for sprue puller and stripper plate. The parts are molded under 16,000 lbs. pressure at 350 F. and 50,000 lbs. clamping pressure.

Another manufacturer made an extensive study of Kirksite dies for high-pressure transfer molding of phenol formaldehyde, urea formaldehyde and phenol furfural molding compounds and for compression molding of laminated plastics. The zinc alloy molds

Fig. 5. Two views of the saddle patch produced in the die shown in Fig. 2.

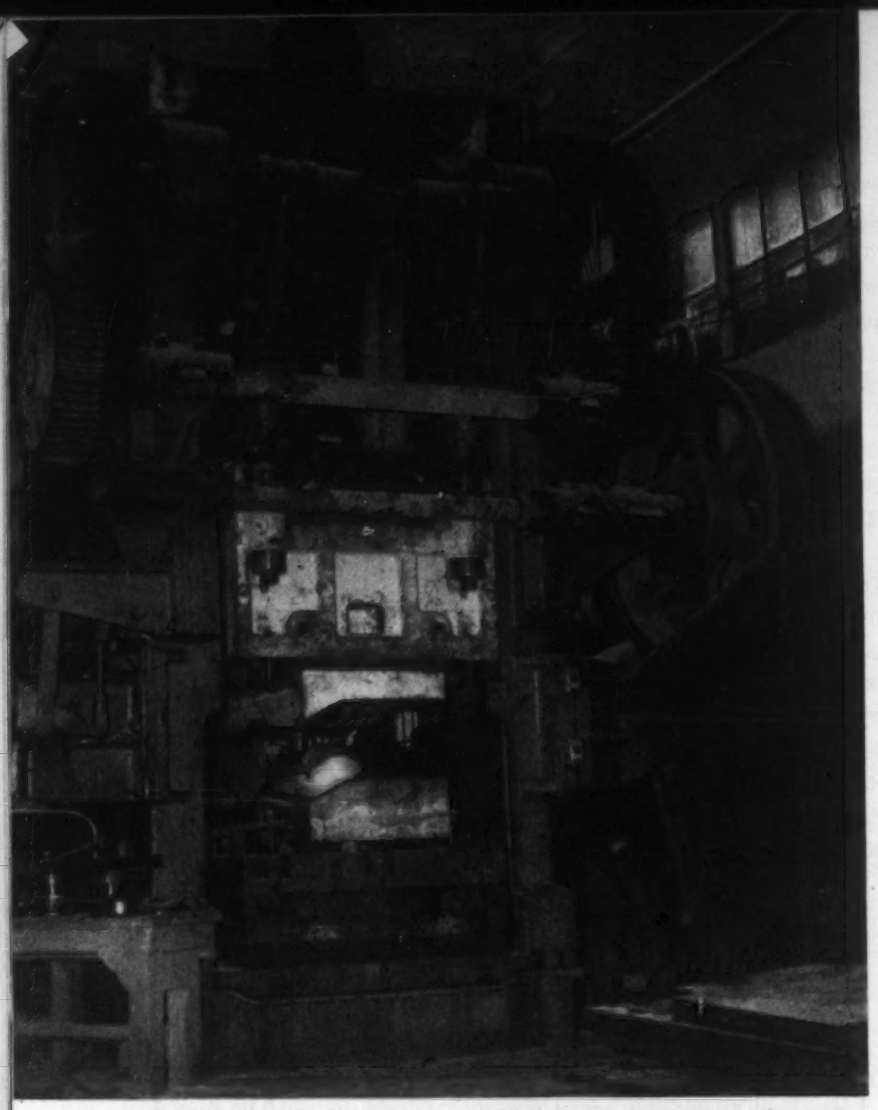


Fig 6. The Kirksite die set illustrated in Fig. 8 is here shown installed in a 200-ton Bliss press.

Fig. 7. These are the plaster patterns for a three piece Kirksite die which has produced 2,100 parts of 0.108 in. stainless steel in a single draw. The part produced is a muff stamping for the Cessna Bob-Cat.

were found to work satisfactorily; hobbing was more difficult than with steel molds for the cast Kirksite "A" lacks the ductility of steel, but the Kirksite was much cheaper and has the unique property of not sticking to the molded plastic part.

General Comments

Other "tooling" uses for this zinc alloy that are not exclusively "aeronautical" include form blocks for deep drawing on hydraulic presses; stretch press dies; chuck jaws cast in permanent molds, which reduce both time and expense and last indefinitely; anti-chatter pads for milling operations; sand-cast tube-bending dies that save costly machining operations; heated dies for forming magnesium alloy sheet at 300-450 F.; jigs and fixtures for assembly purposes.

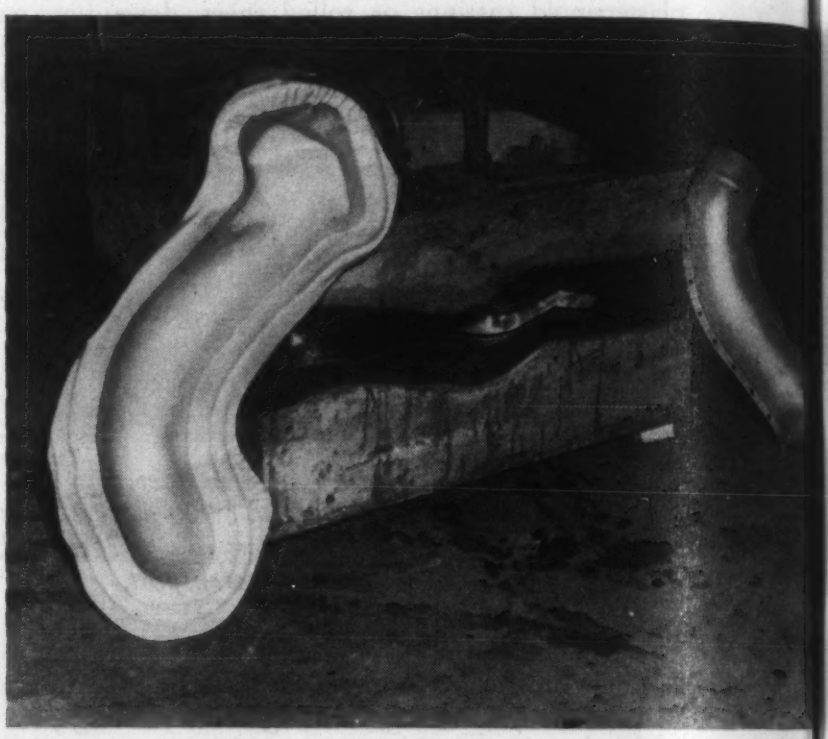


Fig. 8. The starter die for an elbow of the P-38 airplane. The stamping to the left is the product of this set of dies. The part to the right is the finished stamping. It was formed from the starter die stamping by a single blow in the finish die in a drop-hammer.

The aircraft industry must therefore be thanked for having developed a type of low-cost tooling that is certain to be a boon to many other fields after the war. Now considered as full-run or permanent tooling for the stamping requirements of virtually all airplane plants, zinc alloy dies can be similarly applied in making parts for expensive or custom-made automobiles, housings for oil burners, vending machines, special business machines, metal furniture, certain cooking utensils, lighting fixtures, etc.

As "temporary tooling" they will also invade many other fields as well. To these they will bring design flexibility because of their low cost and the permissible rapid production of trial dies. Customer reaction to experimental designs can be obtained without building costly steel tools to produce them.

A Materials Article Structurally a cross between a pearlitic malleable iron and a spheroidized high-carbon steel, the cast engineering material known as "Z-Metal" offers an interesting combination of properties to the designer and has developed many important applications, which Mr. Albrecht reviews in this article.

Strong, Light Iron Castings

by **W. M. ALBRECHT** *Metallurgist, Chain Belt Co., Milwaukee, Wis.*

The increasing demand by engineers and designers for a cast material of high strength at lower unit weight has presented a perplexing problem and a number of solutions have been attempted. For various products and in varying degrees the materials offered and used have ranged from the *strong* cast ferrous metals through the *strong* cast copper alloys to the *light* cast aluminum alloys. Each has found its place and the areas of overlapping and competition among them is surprisingly small.

At the Chain Belt Co. we are in the position of being both a manufacturer and a consumer of several cast ferrous metals—ordinary malleable iron castings, several grades of gray cast iron, and the special spheroidized iron castings known as "Z-Metal" that are the subject of this article. Our experience has shown that the last-named material ideally fits for many applications the basic requirements of high strength without excessive weight, and at reasonable cost, and we have made and employed Z-Metal castings for a host of uses.

In its general characteristics this material is much stronger than malleable iron and stronger than certain types of steel forgings and steel castings. Although its properties are similar in some respects to those of the so-called "pearlitic malleables" it is not exactly one of these (it is not, indeed, a heat-treated malleable iron in the usual sense at any stage of its manufacture), as the subsequent discussion will show.

General Characteristics

The physical properties that make irons of this type so interesting are obtained by close metallurgical control, inexpensive alloying and uniformity of heat treatment. This might at first thought suggest expensive and elaborate foundry equipment but the contrary is the case. It can be made with the equipment

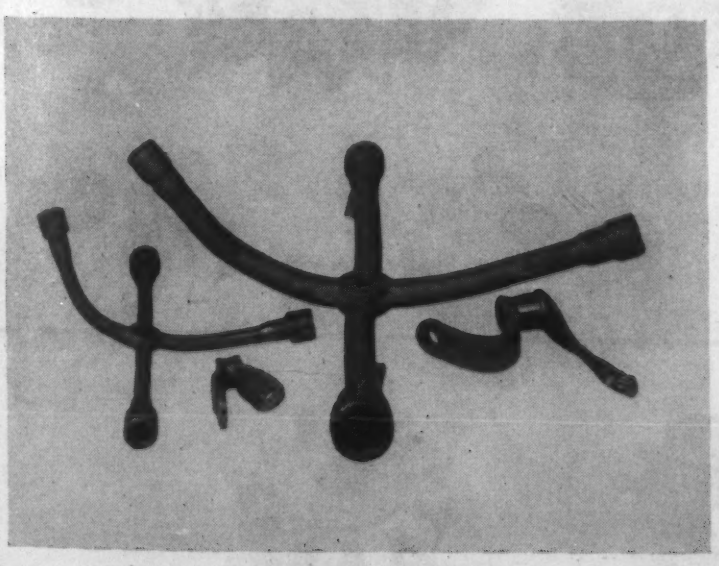


Fig. 1. Cross wrenches and chain links, which have been bent far beyond any reasonable service requirement, demonstrate the adequate toughness of spheroidized iron castings.

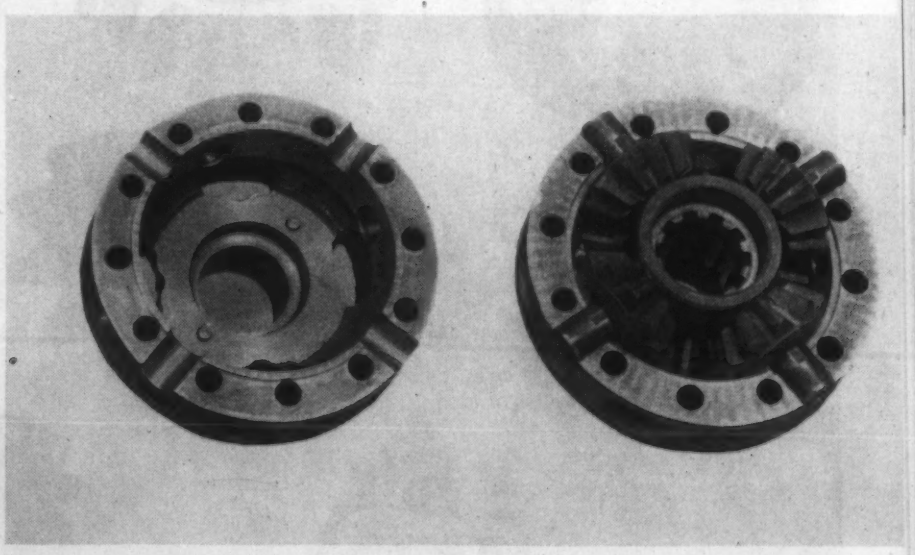


Fig. 2. Two-piece housing for bevel gears of a truck differential. Z-Metal replaced malleable iron in this application because it offered greater wear resistance to the thrust of the bevel pinions.

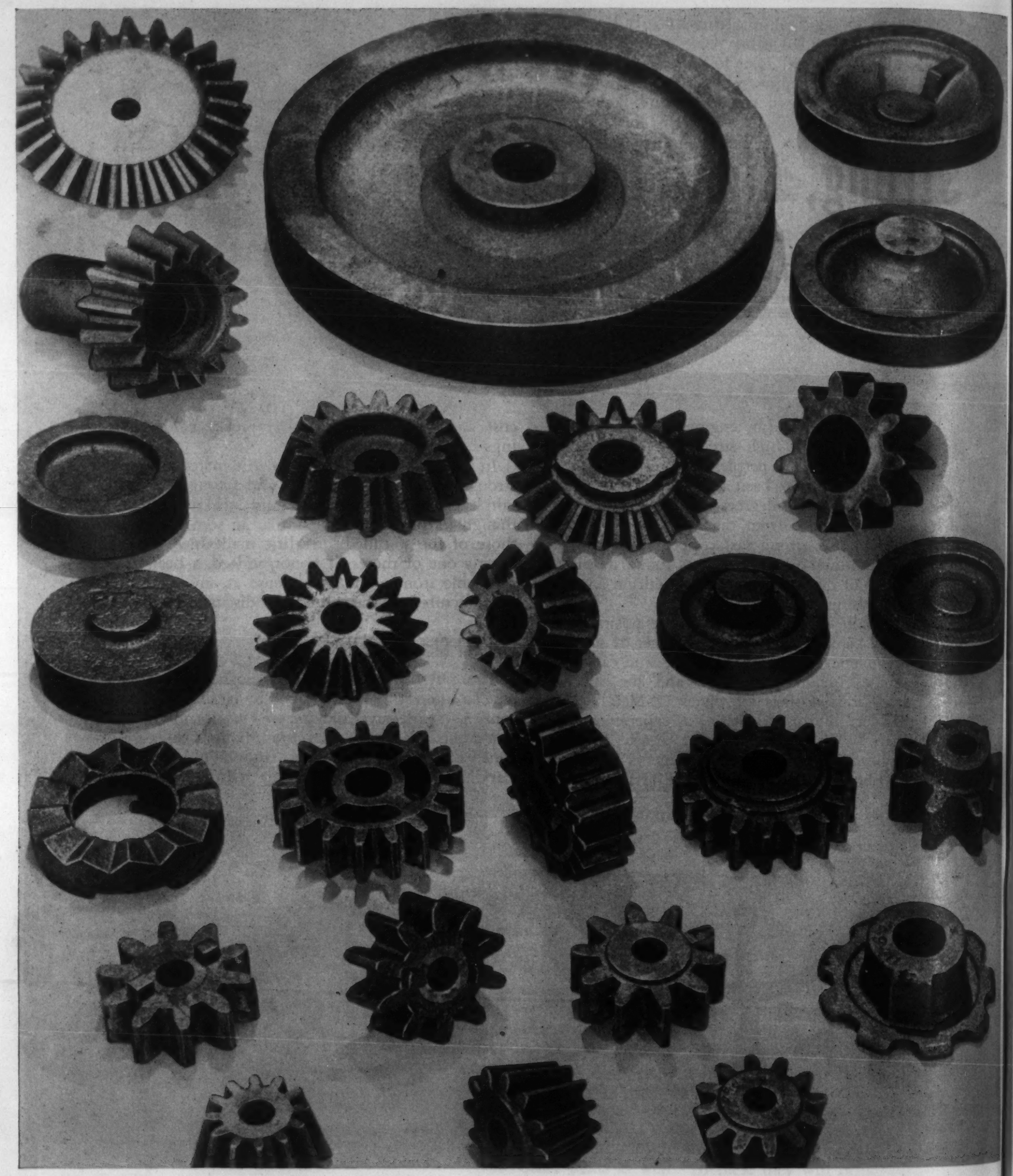


Fig. 3. These Z-Metal gears, both cast and cut tooth, have been used on many applications, among them agricultural machinery, many power transmission case units, pumps, etc.

of a regular malleable foundry by adding only equipment for heat treating.

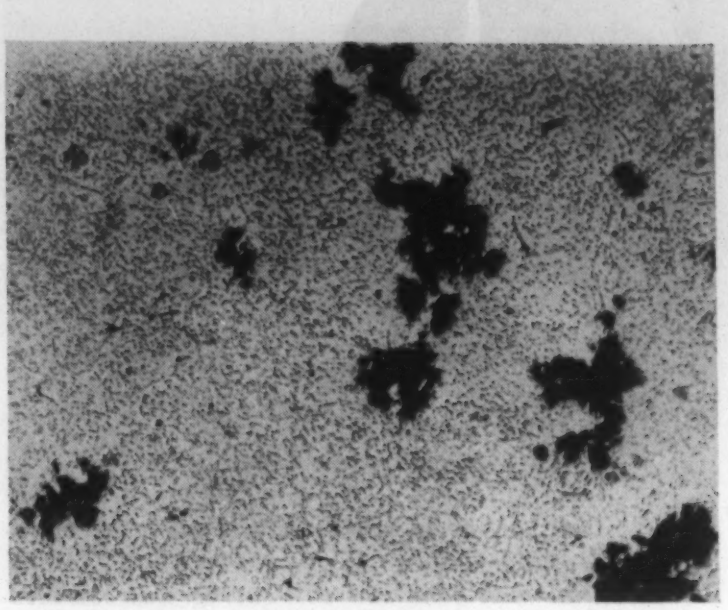
Briefly, the process consists of adding manganese and copper as alloys to a regular white iron base metal. The heat treatment consists of an annealing operation at 1600 to 1700 F for about 48 hrs. [Editors note: We understand that several plants are able to apply shorter Z-Metal annealing cycles, of the order of 20-36 hrs., by using somewhat higher temperatures and higher-silicon analyses] followed by air quenching and then by reheating to 1250 to 1350 F, for 15 to 30 hrs. (depending on size and section of the castings) as a toughening or spheroidizing operation. The manganese alloy stabilizes the structure so that reasonable manufacturing allowances in heat treatment will permit the production of a uniform product with consistent properties. These are patented features which have led to the licensing of the manufacturers of Z-Metal by Ferrous Metals Corp., New York, owners of the covering patents.

Z-Metal can be cast into any shape which malleable iron will take and we have yet to find a case where, from an engineering point of view, it cannot be substituted; and this without changing existing pattern equipment. This offers the distinct advantage of being able to change from a lower to a higher strength material without expensive pattern changes and redesigning.

While the cost of Z-Metal is somewhat higher than malleable iron its properties have resulted in far superior performance for our products. For example, power transmission chains of Z-Metal selling at a premium of about 20% over malleable chains have shown an increased life of 100% in many replacement applications.

Z-Metal castings generally cost less than commercial carbon steel castings while their properties are comparable. The cost advantage that is usually gained has on numerous applications made Z-Metal an attractive choice when considering the best material to do the job. Some important and highly stressed castings are shown in Figs. 2 and 3.

The microstructure of Z-Metal, which is in part responsible for many of its properties, is shown in Fig. 4. Here can be seen the hard particles of spheroidized cementite embedded in a tough iron, giving



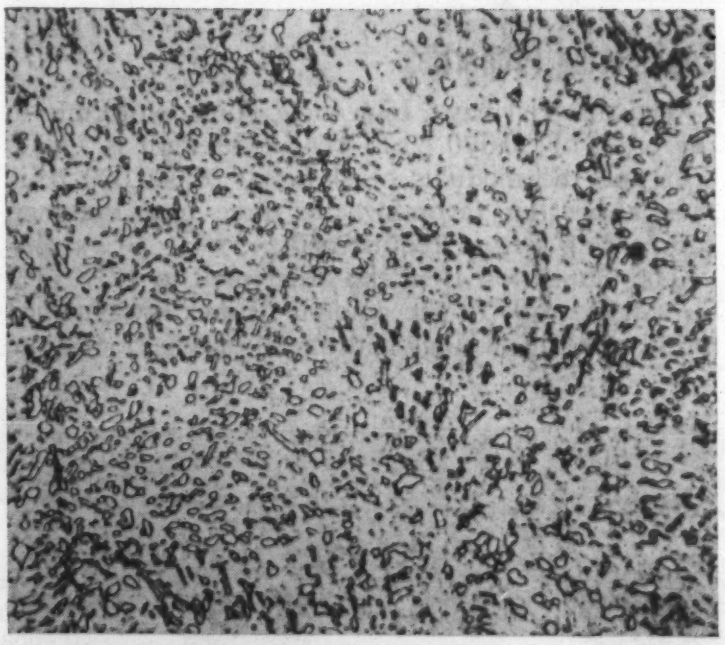
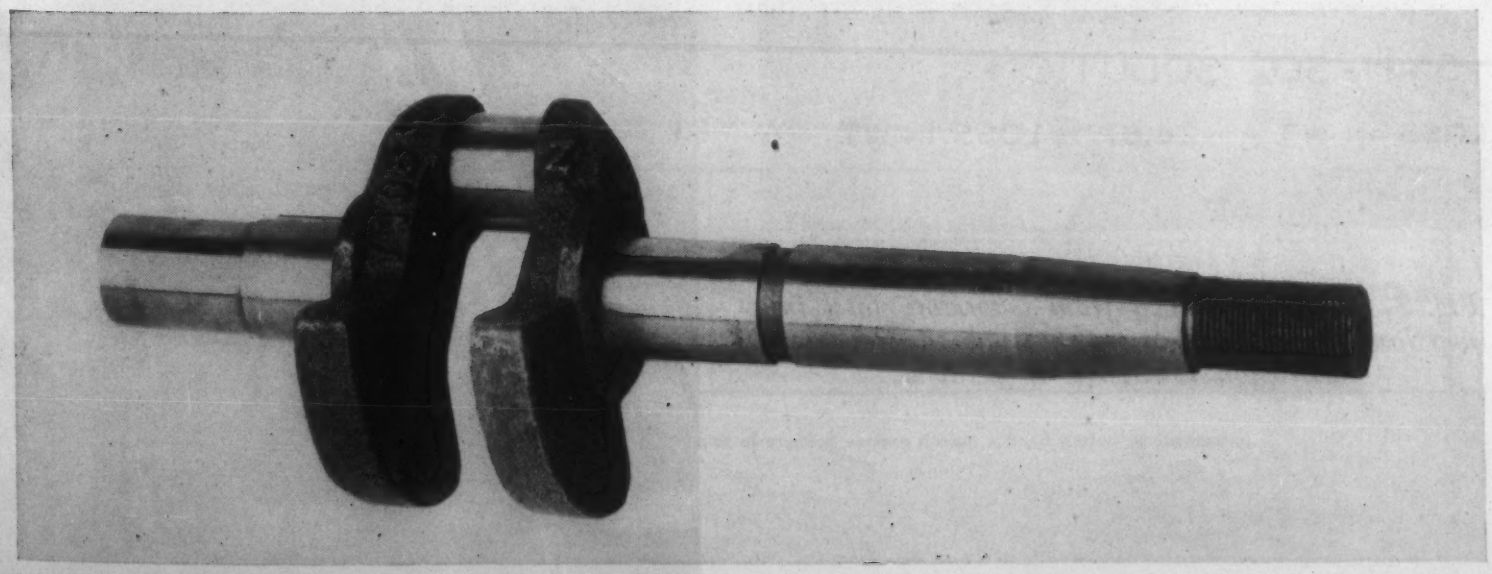


Fig. 4. This shows the black temper carbon-nodules as well as the hard spheroidized cementite which is embedded in a background of tough ferrite or iron. Upper micro is 200X; lower, 800X.

Fig. 5. These bearing surfaces indicate the smoothness which can be obtained in these spheroidized iron castings.



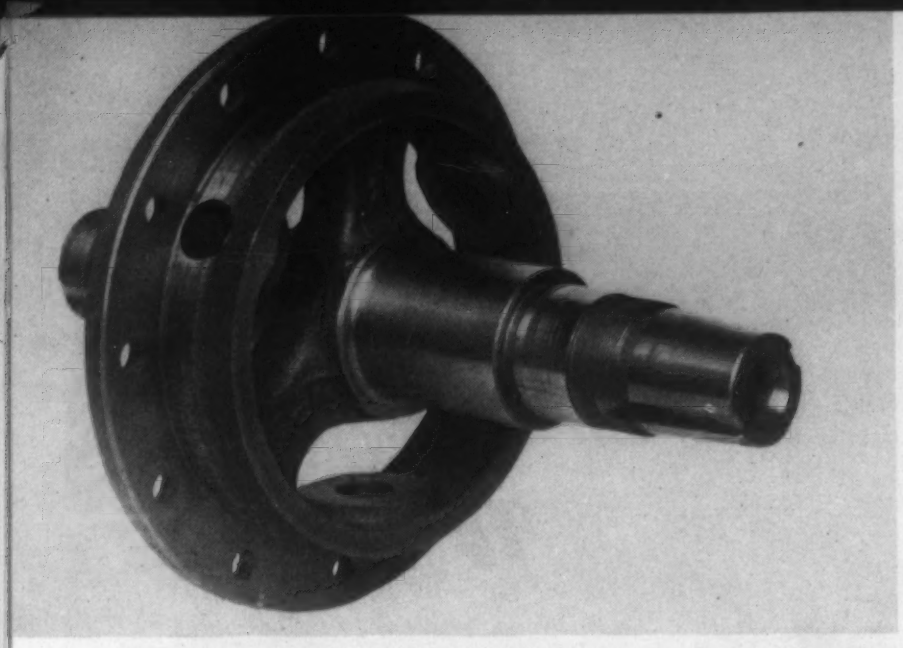


Fig. 6. This casting at one time was made by pressing a shaft into a forging. When converted to Z-Metal a substantial man-hour and cost saving was obtained in addition to extremely smooth bearing surfaces.

a combination of high strength, wear resistance and satisfactory toughness.

Engineering Properties

The material has a high yield point, uniformly in the order of 50,000 p.s.i. Tensile strength is 75,000 p.s.i. and the modulus of elasticity 27,000,000 p.s.i., thus answering favorably the three most common engineering design requirements.

The elongation is in the order of 8 to 12% in 2 in. An example of the amount of ductility obtained in engineering castings with metal of 8% elongation, is shown in Fig. 1. This shows castings which are deformed far beyond any reasonable service requirement and demonstrates the engineering toughness and ruggedness of castings of this type. It also shows that having a material of any higher elongation would add very little if anything to the desirable properties. The rigidity, high yield strength and substantial margin of safety provided by toughness before ultimate strength is reached, demonstrate the "balanced properties" that every designing engineer earnestly seeks.

Probably next in importance is the ease of machining. At equivalent hardness, Z-Metal is one of the most easily machined ferrous metals known. The reason for this can be understood from the microstructure of evenly distributed globules or spheroids of cementite. This structure has long been recognized for its ease of machining. In addition, the black temper graphite particles aid in cutting the metal by producing a "lubricating" effect. Z-Metal finishes smooth and clean without chipping or tearing and

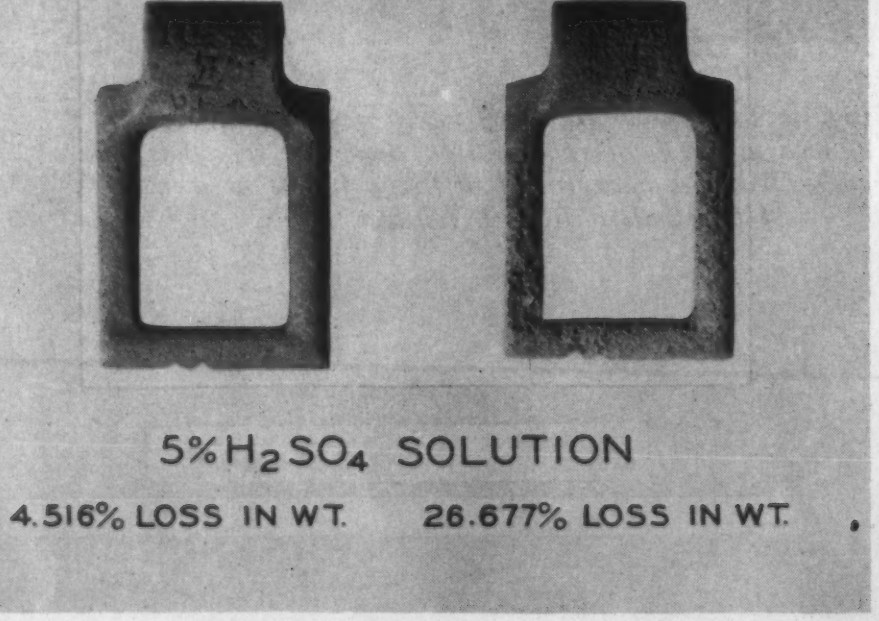
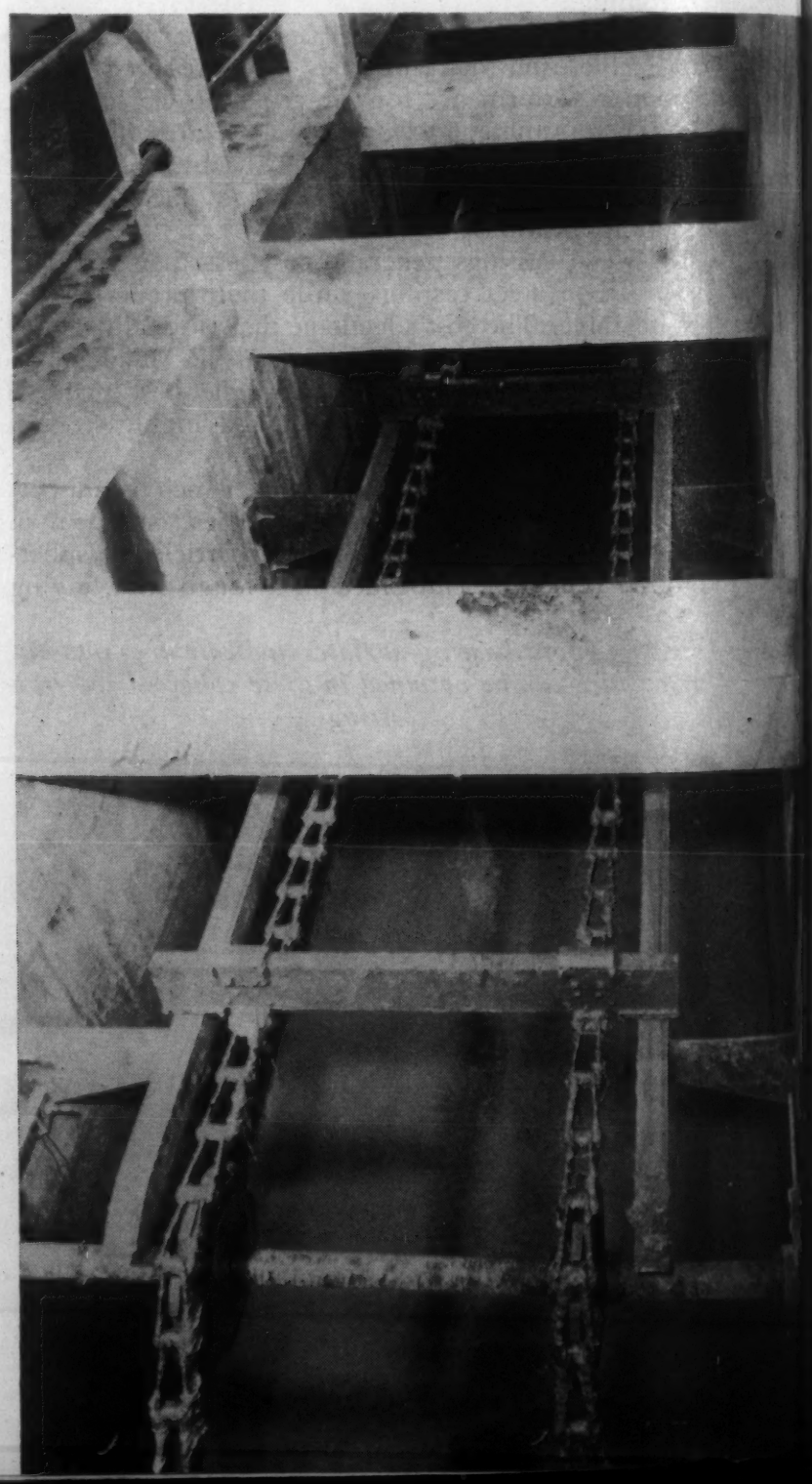


Fig. 7. Specimens taken from laboratory total immersion comparative tests, showing the improved corrosion resistance of Z-Metal.

Fig. 8. This shows an installation of Z-Metal chain in a sludge collector, demonstrating the unfavorable conditions of abrasion and corrosion which this chain successfully withstands.



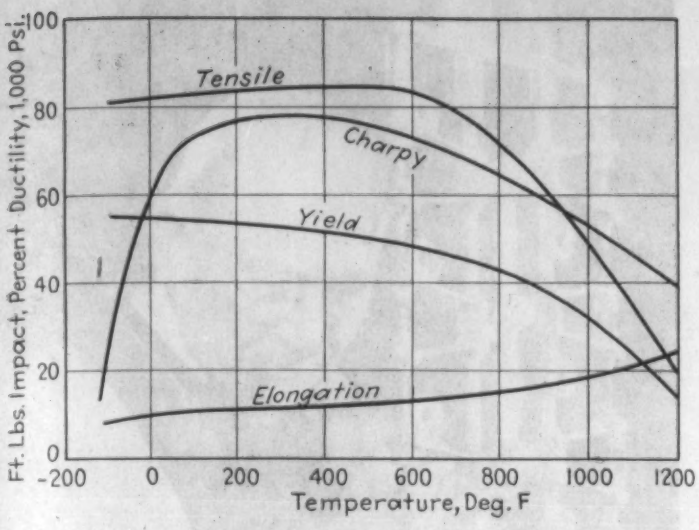


Fig. 9. Physical properties of Z-Metal.

will take a bright polish upon grinding as is demonstrated in Figs. 5 and 6.

Because of the casting accuracies which can be maintained, very often a distinct overall cost advantage can be gained as a result of having to remove less metal where machined surfaces are required. In addition the appearance of a machine may often be improved because of a blended design with rounded corners not practical with wrought and welded parts.

The Brinell hardness is in the range of 170 to 190. This again is a result of the hard spheroids of cementite which offer good wear resistance. The temper carbon particles function in much the same way as in graphitic steels and Z-Metal, which in effect is a graphitic steel, has in many instances proved to be a superior bearing material because of this quality.

Special-Service Properties

The alloying element that makes Z-Metal corrosion resistant dissolves in the iron and has the property of forming a film which subsequently protects the metal from further corrosion. The relative corrosion rate is shown in the Table.

Tensile strength at elevated and reduced temperatures is also an important property. These values are shown graphically in Fig. 9 and indicate that the properties are not substantially affected by a normal change in temperature of from 0 F to 700 F. For convenience, the impact strength is also shown on this graph, using an unnotched Charpy impact bar.

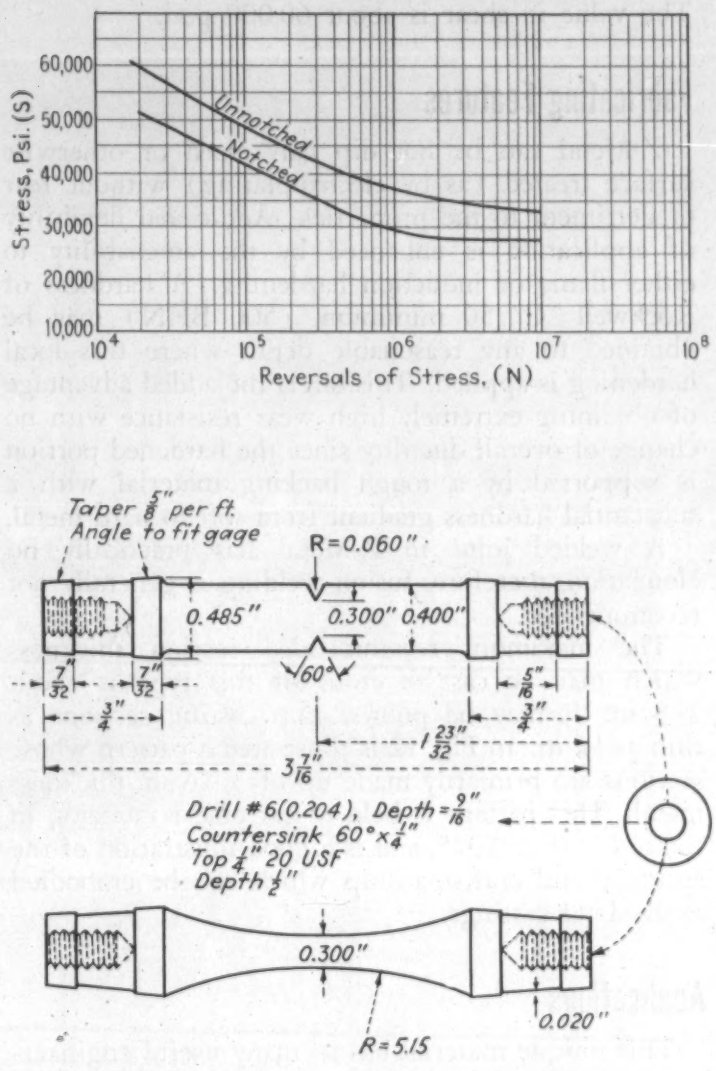


Fig. 10. Fatigue strength of Z-Metal. The upper diagram shows the dimensions of the test specimen.

The fatigue or endurance limit is 32,500 p.s.i. In addition iron castings of this type have been shown to be less notch sensitive in fatigue than steel. This is an important consideration in designing. The "K" ratio, which is a measure of notch sensitivity, is 1.20. A graph showing the endurance limit of notched and unnotched specimens is given in Fig. 10.

Compression tests conducted on a cylinder 15/16 in. in diameter by 3 in. long have shown the yield strength in compression to be 53,000 p.s.i. and the ultimate compression strength to be 200,000 p.s.i. The photograph, (Fig. 11) of the fractured samples pictorially demonstrates the toughness at these extremely high stresses. The method of fracture along

Relative Corrosion Resistance from Laboratory Determination
(Parts submerged and not under strain—Temperature 80 F.)

Material	* *Salt Water 10% Solution*	*Mine Water (Coal)*	*Sugar Cane Solution*	*5% Sulphuric Acid*	*25% Tannic Acid*	*5% Lactic Acid*	*5% Hydrochloric Acid*
Z-Metal	0.016	0.00715	0.099	2.68	0.047	0.075	0.455
Gray Iron	—	0.1178	1.632	11.09	0.062	—	13.150
Malleable Iron	0.052	0.1680	1.628	27.57	0.087	1.190	11.181
Stainless Steel (Type 410)	0.001	0.0086	0.080	4.30	—	—	0.252

* Alternate submersion.
These figures represent the loss of metal in milligrams per square centimeter of exposed surface during a fixed period of immersion.

the 45° slip plane is typical of most ferrous metals. The value in shear is about 60,000 p.s.i.

Fabricating Features

Z-Metal can be hot dip galvanized or otherwise surface treated (as by electro-plating) without fear of detriment to the properties. Additional flexibility of application is enhanced by the amenability to either flame or induction hardening. A hardness of Rockwell "C" 50 minimum, (500 BHN) may be obtained to any reasonable depth where this local hardening is applied. This offers the added advantage of obtaining extremely high wear resistance with no change of overall ductility since the hardened portion is supported by a tough backing material with a substantial hardness gradient from soft to hard metal.

A welded joint in Z-Metal has practically no elongation, therefore, fusion welding is generally not recommended.

The maximum recommended section thickness which may be cast of irons of this type is about 1½ in. It may be poured into casting sections as thin as ⅛ in. In Fig. 12 is illustrated a pattern whose sections are primarily made up of 3/16 in. thickness metal. This pattern is held to extreme accuracies, in the order of ±0.015, and is a good illustration of the accuracy and craftsmanship which can be embodied in Z-Metal castings.

Applications

This unique material has so many useful engineering properties that in addition to being employed for many years on well established peacetime products in widely diversified fields, it also has become widely used for war requirements. Many of its applications are shown in the accompanying illustrations. The postwar uses for Z-Metal not only offer malleable foundries the opportunity of broadening their markets, but in a larger sense can be the solution to many materials-engineering problems of design engineers throughout the metal-working industries.

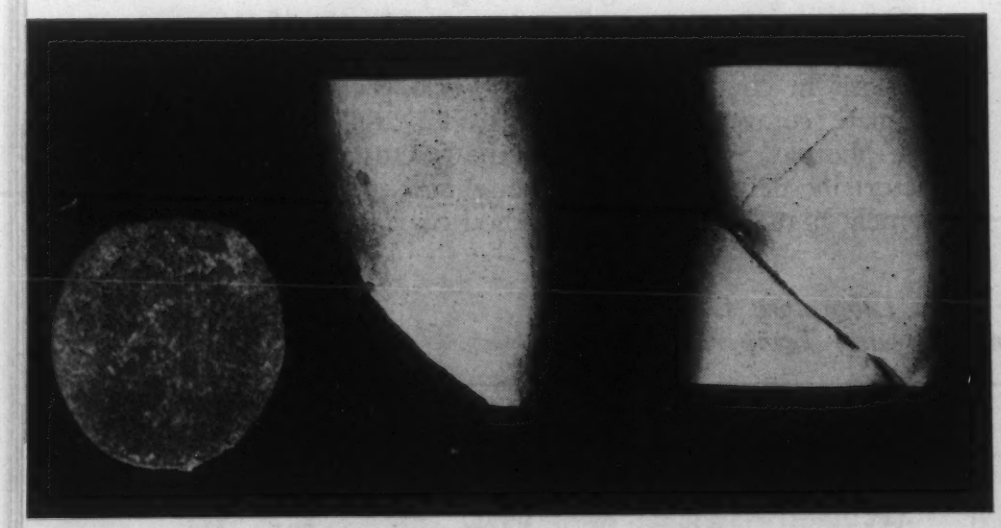


Fig. 11. Compression samples showing toughness and characteristic failure along the 45° slip plane.

Fig. 12. Skill and craftsmanship enables castings of this material to be cast in very thin sections to within ±0.015 in.

Typical present and post-war applications are as follows:

Railway Parts	*Machine Parts*
Carry Irons	Gears
Hinges and Brackets	Hardened Machine Gears
Spring Retainers	Cranks
Brake Shoes and Heads	Levers
Automotive Products	Chain Links
Camshafts	Chain Sprockets
Crank Shafts	Rolls
Differential Housings	Pump Parts
Rear-Axle Truck Housings	Nozzles
Motorcycle Parts	Cams
Fittings	Connecting Rods
Unions (High Pressure)	Elevator Buckets
Couplings (Hose Connections)	Drive Spiders
Valve Bodies	Hydraulic Jack Bodies
Tools	Rocker Arms
Wrench Handles	Universal Joints
Hammer Heads	*Miscellaneous*
Clamps	Bolts and Nuts (Pipe Line)
Pipe Wrenches	Highway Devices
	Pipe Line Couplings
	Tractor Treads

A Methods Article Electric furnaces for hardening, annealing, brazing, etc. generally require automatic control, which is usually magnetic control by means of contactors. The types, performance ratings and applications of such magnetic controls, and the control panels and other accessories used are described in this article.

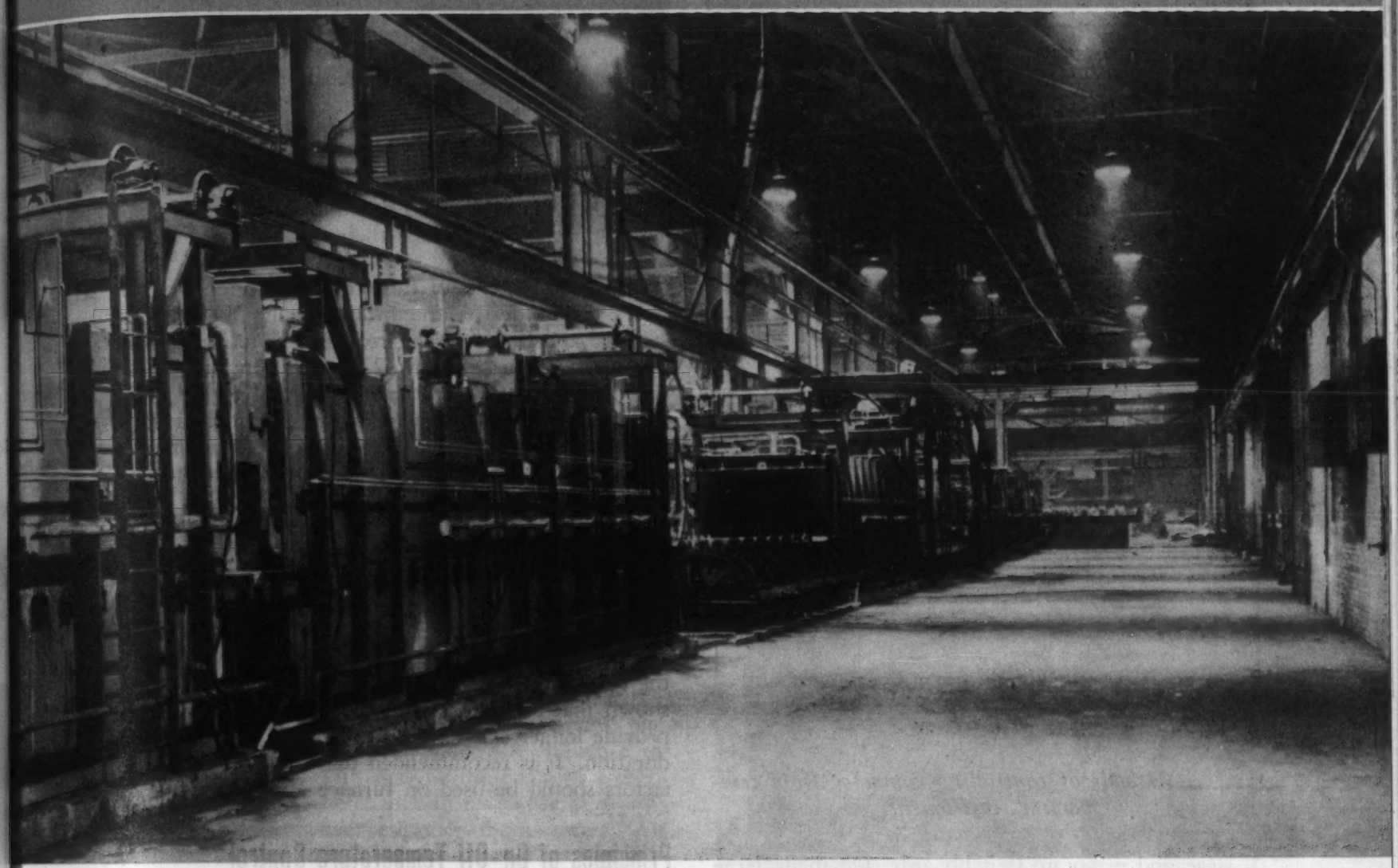


Fig. 1. General view of 7-chamber roller hearth furnace for annealing 25-ft. alloy steel bars.

Magnetic Controls for Electric Furnaces

by **G. W. HEUMANN** *Industrial Control Engineering Div., General Electric Co., Schenectady, N. Y.*

DURING RECENT YEARS a large number of electric furnaces have been installed in industrial plants for a variety of heat-treating applications such as annealing, hardening, normalizing, brazing, carburizing, and drawing. They range in size from small batch-type furnaces for tool room use and the heat-treating of small parts, to elevator furnaces handling eight tons of aluminum sheets and roller hearth furnaces for annealing 25-ft. alloyed steel bars in a continuous process, such as shown in Fig. 1.

The amount of power required for furnaces, except a few of the very small ones, is too great to be handled directly by a thermostatic controller. Manual control of temperature would be too cumbersome and inaccurate. Practically all electric furnaces require automatic control. Except for special applications in which the greater accuracy of electronic control warrants its higher cost, magnetic control by means of contactors is used.

The power requirements of electric furnaces vary from a few to many hundred kilowatts. Thus magnetic controls range from small single contactor panels

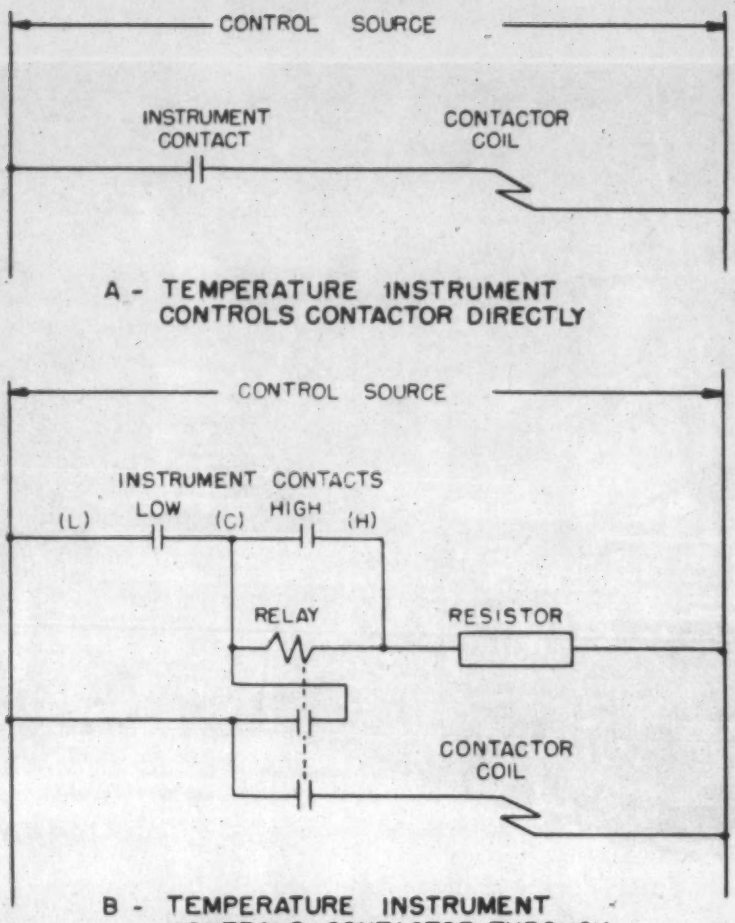


Fig. 2. Methods of controlling contactor from temperature instrument.

to large and elaborate switchboards. On many large furnaces, such as truck, elevator, conveyor, and roller hearth types, motorized drives are used to facilitate the handling of material being heat treated.

In designing controls for the motor drives, magnetic controls offer the advantage that automatic sequences can be set up and properly interlocked to prevent damage to the furnace, the charge, or to the operating personnel. Electric furnaces offer a wide field of application to magnetic control.

Contactors for Temperature Control

With few exceptions a-c power is available in all industrial plants, and the power circuits of furnaces are customarily connected to available a-c systems, usually 440 or 220 volts. Contactors for controlling the power circuits of electric furnaces are conventional low-voltage a-c types. The load on the contactors is practically constant, the load current being determined by the resistance of the heating units. There is no load factor, as in the case of motor applications. Contactors are applied to furnace control on the basis of a current rating of 90% of their standard continuous rating.

During the warm-up period of a furnace, contactors may stay closed for a considerable time. Consequently, they are equipped with silver-faced contacts to prevent oxidizing and freezing. While the furnace is regulating, contactors will open and close frequently, often several times a minute. This calls for contactors capable of withstanding frequent operation. Contactors rated at 540 amperes and above are equipped with solid magnets and d-c operating coils to assure long life of the contactor magnet. Contactors of smaller size can also be obtained with d-c magnets, to be operated either from an available d-c shop supply or from an a-c supply through rectifiers. Although the cost of contactors with d-c magnets is higher, their use is often warranted because of their longer mechanical life and their reduced maintenance requirements.

The requirements of furnace design often make it necessary to design the heating units for low resistance and high current, requiring a terminal voltage at the furnace below 220 volts. In such cases, the furnace heating units are connected to the available 220- or 440-volt shop supply through a step-down transformer, and the control contactors are connected in the primary side of the transformers. It is then necessary for the contactors to close in on the inrush current of the transformer, the instantaneous peak value of which may be as high as 30 times normal current. Contactors must be able to handle such peak currents without freezing.

As a furnace load is a pure resistance load, it has not been considered necessary in the past to equip the contactors with blowouts. Recent experience has shown that contactors with blowouts and arc chutes provide longer contact tip life because of shorter arc duration. It is recommended that blowout type contactors should be used on furnace applications.

Principles of On-Off Temperature Control

The basic elements of a magnetic on-off control are the temperature-responsive instrument and the contactor. The instrument contains one or several electric contacts which energize or deenergize the contactor, and thus apply or remove power from the heating elements of the furnace. The following types of instruments are most commonly used: Direct acting thermostats and pyrometers, millivoltmeter and potentiometer type instruments:

1. Direct acting thermostats and pyrometers depend on the expansion of a gaseous or liquid

Fig. 3. Open group panel for the 7-chamber roller hearth furnace in Fig. 1, shown in the control room.

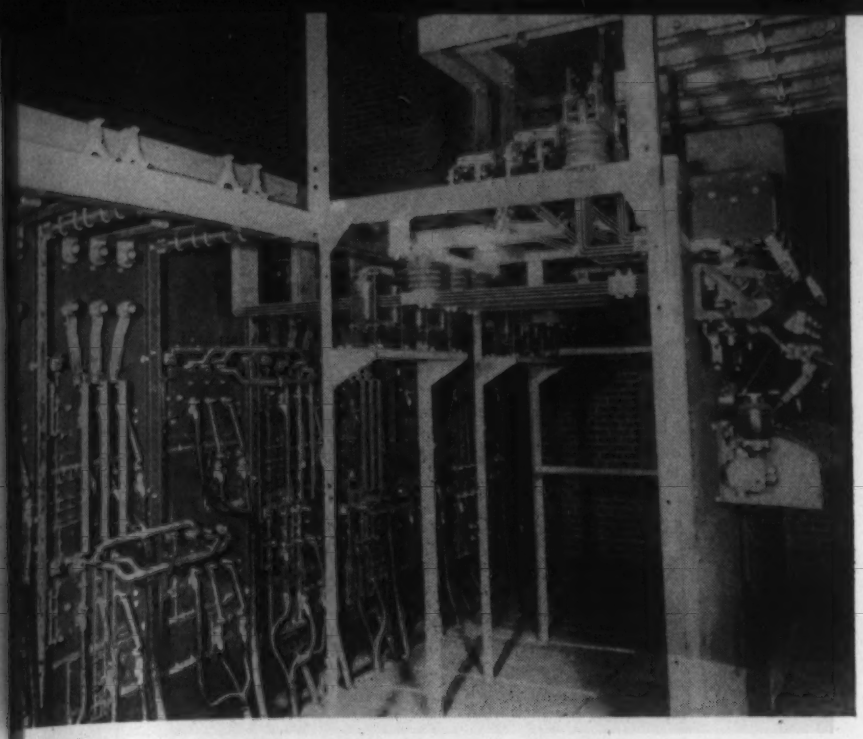


Fig. 4. Back view of panel in Fig. 3 showing bus structure and circuit breaker panel on the right.

medium which is confined in a bulb or expansion tube and which, by mechanical action, operates the pointer and the contact of the instrument.

2. Millivoltmeter type instruments work in conjunction with a thermocouple, the e.m.f. of which is used directly to actuate the pointer and the contact.
3. Potentiometer type instruments contain a standard cell as reference and a bridge circuit, one leg of which changes under the influence of temperature. This may be the e.m.f. of a thermocouple or the change in resistance of a temperature-sensitive resistance thermometer. An extraneous force, such as a small motor, balances the bridge and provides the power to operate the pointer and the contacts.

How the contacts of the temperature-sensitive instruments control the contactor is illustrated in Fig. 2. In circuit A the contact of the instrument actuates the contactor coil directly. As long as the temperature is below the setting of the instrument, its contact is closed and the contactor is energized. When the temperature reaches the setting of the instrument, its contact opens and drops out the contactor. This simple method of control can only be used if the instrument contacts have sufficient carrying and interrupting capacity to handle the contactor coil.

Many highly sensitive temperature control instruments have contacts too delicate to interrupt the contactor coil directly. Referring to circuit B, Fig. 2, the instrument is equipped with two contacts. The "low" contact is closed as long as the temperature is below the instrument setting, and it opens when the temperature reaches the setting. The "high" contact closes when the temperature rises above the setting, and it opens when the temperature drops to the setting. There should be a slight underlap between the "low" and the "high" contacts so that both will never be closed at the same time.

With such an instrument, a thermostatic relay is used to actuate the contactor. The relay is so designed that it requires a coil of low wattage. When the "low" instrument contact closes, the relay is energized and seals itself in. When the "high" contact closes, it short-circuits the coil of the relay, which drops out. Thus, the instrument contacts only make and carry, but never break the current.

Overload Protection

There cannot be any overloads on a heating circuit such as may be encountered on motors. However,

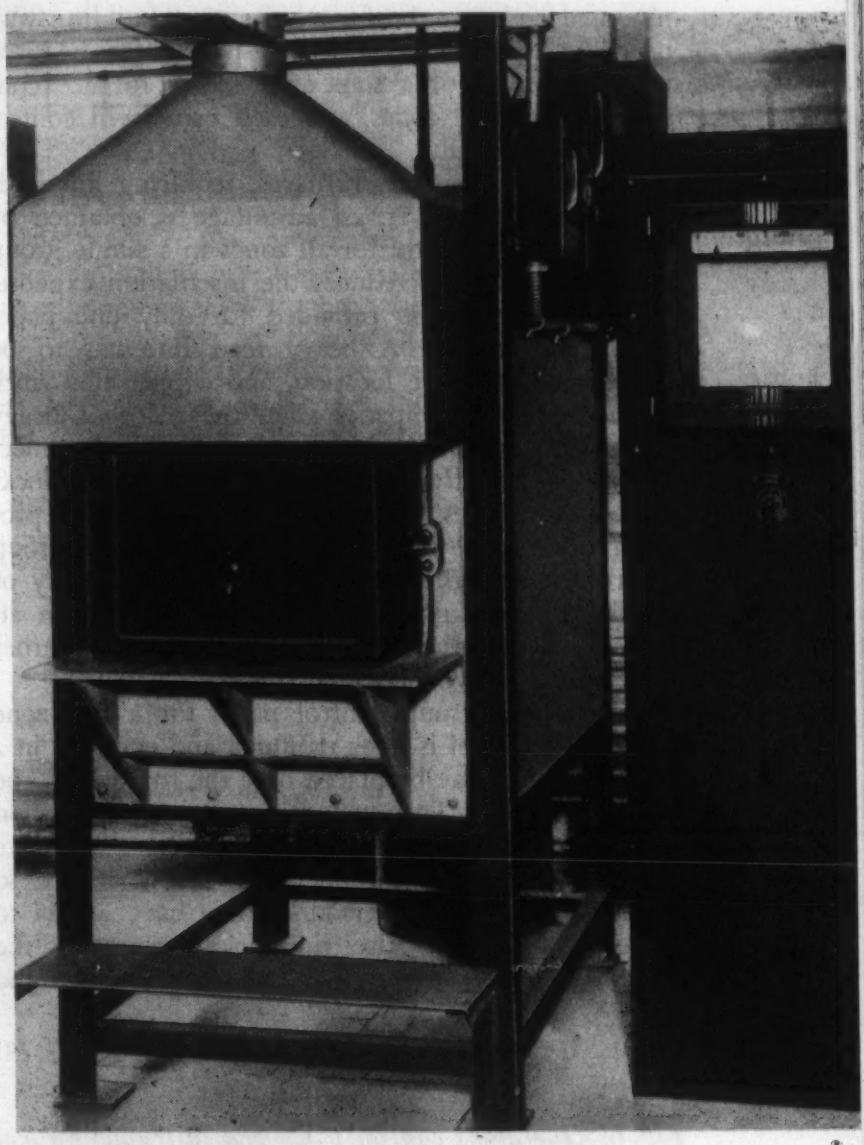


Fig. 5. Instrument panel mounted adjacent to the box furnace.

heating elements in the furnace may deteriorate and break after a long period of service, thus causing short circuits. Fuses or instantaneous overload relays are used for protection. Fuses should be selected for a current at least 20% above the rated current of the furnace. Overload relays should be set for a similar tripping current. If overload relays are used in the primary circuit of transformers, they should have a slight time delay, so that they will not trip on transformer inrush current.

For large furnaces, which may be rated several hundred kilowatts, subdivided into several zones, it is advisable to provide a circuit breaker between the power bus and the main furnace feeder. This circuit

breaker has the purpose of protecting the power system rather than the furnace. Its interrupting capacity should be commensurate with the maximum short circuit current which the power system can produce at the point of the furnace installation.

Heat Control and Instrument Panels

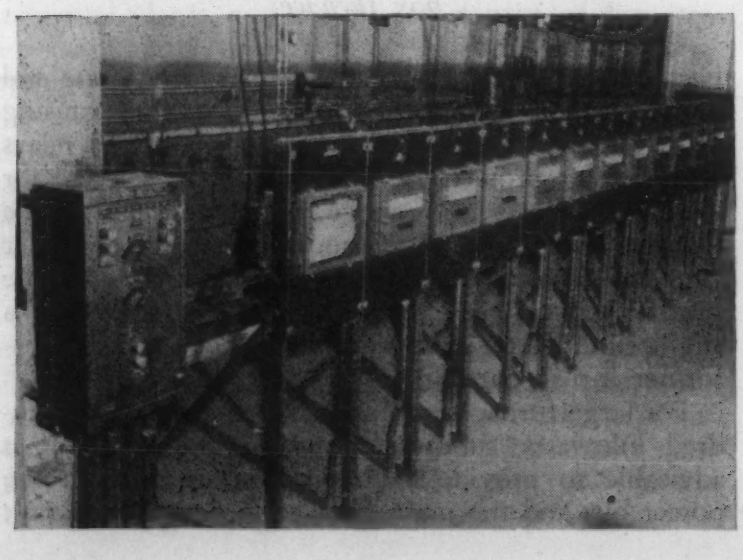
A magnetic control panel for a small furnace contains a contactor, thermostatic relay, and fuses. These devices are assembled on a base and enclosed in a wall-mounted sheet steel case. Such a panel can be mounted right on the furnace or on a building wall near the furnace. Several such panels can be used for the control of a somewhat larger furnace consisting of several zones, and each panel will control a zone individually.

On large multi-zone furnaces, requiring hundreds of kilowatts in power, an advantage is obtained by combining the control for all zones in a single group control panel. This reduces the installation expense. Mounting has to be provided for only one panel instead of several. A heavy feed line has to be brought to only one location, and copper bus work in the back of the panel takes the place of heavy feeder lines which would be required to interconnect a number of individual panels. Also, any interlocking between zones, which may be required when program controls are used, are made right on the group control panel, rather than between a multiplicity of panels. Maintenance work is made easier when all control devices are concentrated in one location rather than scattered over a wider area.

In a typical group control panel for a four-zone furnace, the panel is floor mounted and enclosed in a cubicle, and it may be placed near the furnace on the operating floor. The enclosure provides protection for the operators against accidental contact with live parts. The doors of the enclosure can be locked so that only authorized personnel may have access to the control devices. Also, the enclosure protects the equipment against the accumulation of dust and dirt.

On very large furnaces, the amount of power required may become so great and the control panel so large that it would be impractical to locate it directly on the operating floor. In such a case, an open type panel can be installed in a separate control room.

Fig. 6. Operator's control panel and instrument panel for a 4-chamber roller hearth furnace.



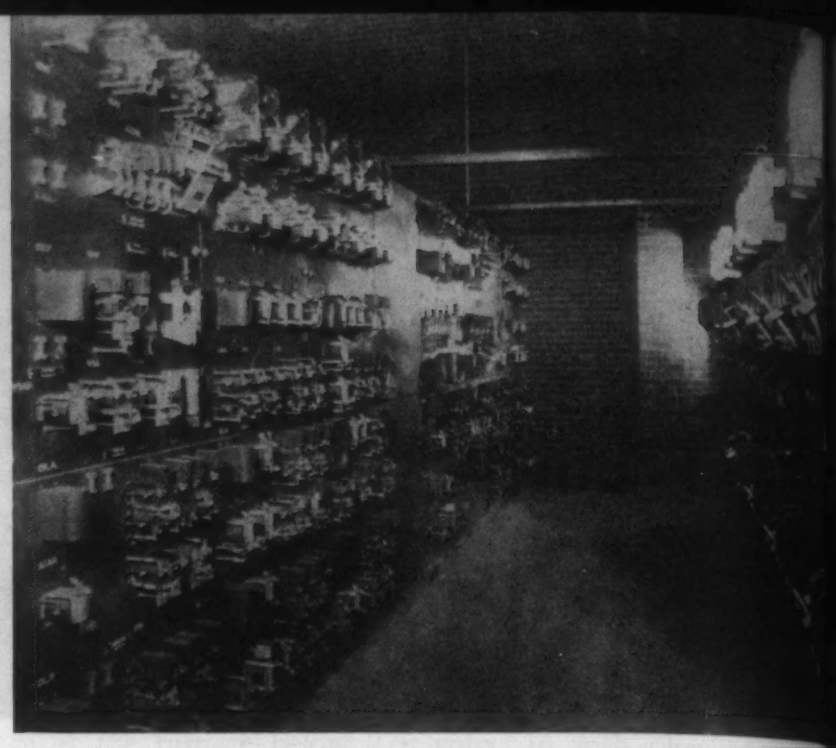


Fig. 7. Consolidated motor control panel for roller hearth furnace of Fig. 1.

Shown in Fig. 3 is the front view of a group control panel for the seven-chamber roller hearth furnace illustrated in Fig. 1. It will be noted that the temperature control contactors have d-c operated magnets. Disconnect switches are provided to permit isolation of each chamber.

A back view of the same panel, showing the heavy bus work in the rear is illustrated in Fig. 4. Here the advantage of a consolidated group control panel over a multiplicity of small individual panels is obvious. To the right is the line panel containing an air circuit breaker connected ahead of the whole furnace power circuit.

The temperature control instruments, which indicate the performance of the furnace and control the power input, should be mounted close to the furnace. This will conveniently enable the operator to maintain a continuous check on the furnace. Shown in Fig. 5 is a full skirted, floor mounted instrument panel installed alongside a box type furnace. In addition to the temperature control instrument, the panel contains a control switch by means of which the control circuit to the heat control contactor can be interrupted, thus shutting down the furnace. Control fuses for protecting the control circuit are mounted in the rear of the panel.

On large furnace installations, the instruments for the whole furnace should be grouped together, thus forming a control center which can be easily supervised by the operator. The control center of a roller hearth furnace consisting of four chambers is shown in Fig. 6. A control switch is provided for each chamber. A light above the instrument for each zone indicates when the contactor of that zone is closed, thus permitting the operator to check whether each zone is regulating properly.

Motor Controls and Limit Switches

Large furnaces may include a variety of motorized drives such as doors, roll tables, conveyors, quench

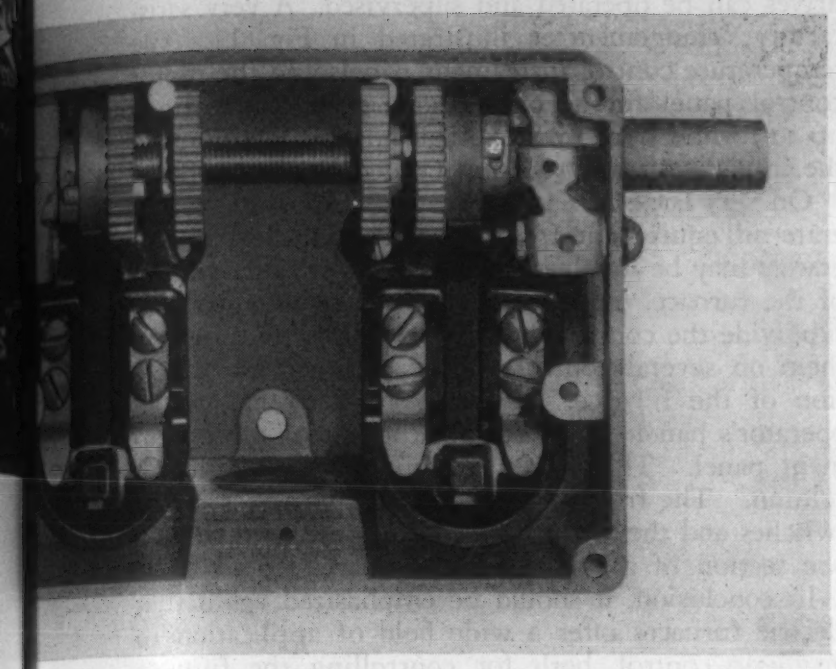


Fig. 8. Small geared type limit switch for control at ends of travel only.

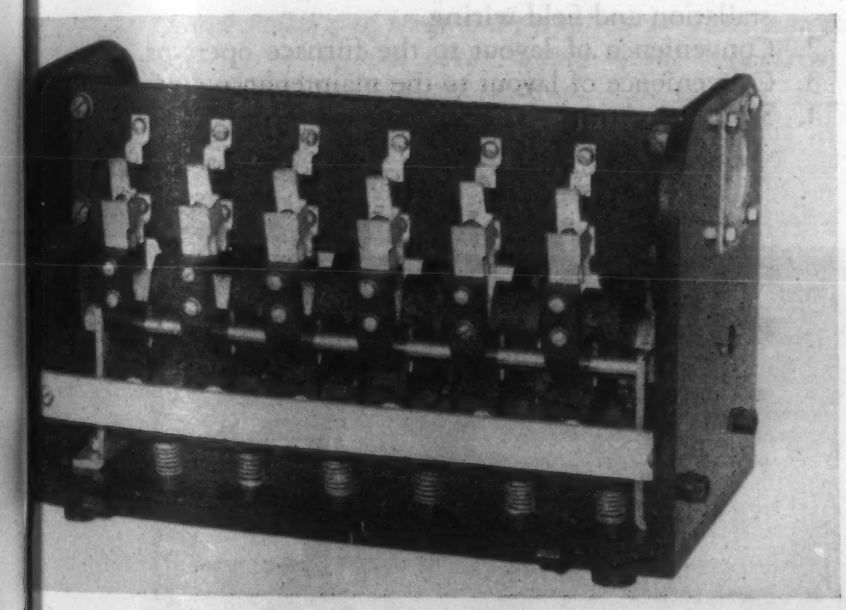


Fig. 9. Large geared type limit switch with circuits individually adjustable for any point of travel.

hoists, bell hoists, truck pullers, and fans. In most cases speed control is not required, and the motors range in size from fractionals up to a few horsepower. Squirrel-cage induction motors with full-voltage starting control are most widely used. If only a few motorized drives are on a furnace, it is most economical to apply standard enclosed full-voltage starters and push buttons, mounted on the furnace. If the control is somewhat more involved and special interlocking is required, necessitating the use of additional relays and timers, it is preferable to assemble the various devices on a combination panel. This simplifies installation and eliminates the necessity of arranging for the mounting and interconnecting of a number of devices. It also makes maintenance easier.

On large furnaces, especially of the roller hearth type, it may be necessary to use adjustable speed motors in order to provide sufficient flexibility for passing material, which varies greatly in size and weight, through the furnace. Adjustable speed d-c motors are then used, and speed is controlled by field weakening. If both a-c and d-c are available in the plant, the adjustable speed drives may be equipped with d-c motors and the constant speed drives, such as doors and fans, may be equipped with squirrel-cage motors. The motor control for large furnaces is necessarily special in nature and must be "tailored" to fit the particular requirements of each installation.

Due to the large amount of interlocking that is often required between the various motor drives, it is highly advisable to combine the motor control for the whole furnace on a consolidated group control panel. Shown in Fig. 7 is the motor control panel for the roller hearth furnace illustrated in Fig. 1. This is an open type panel, installed in a separate control room together with the temperature control panel, which can be seen to the right.

Limit switches are used extensively to stop the drives in the proper position, or to provide interlocking between the various drives to insure that they are operated in the desired sequence. Various designs

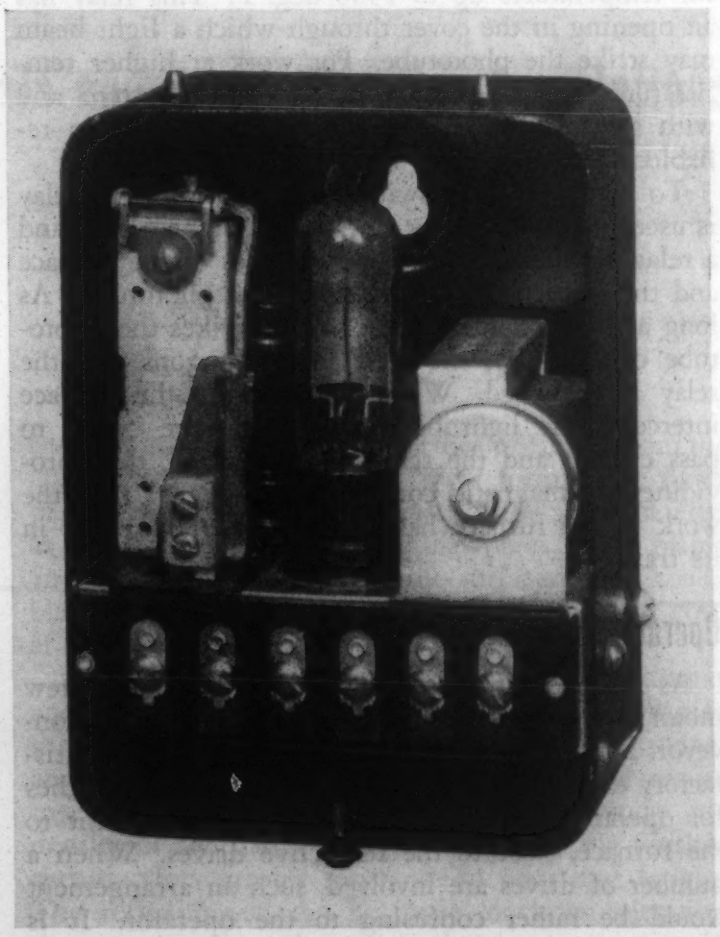


Fig. 10. Typical photoelectric relay for use as a limit switch on a furnace. The cover is removed.

of limit switches are available, either track type or geared type. Track type limit switches are operated directly by a cam, attached to some member of the driven piece of machinery, through an operating lever.

Geared limit switches are connected to some shaft extension of the driven machinery, and they rotate with the drive. Contacts can be set to open or close at selected points of the travel. A small geared switch suitable for use in cases where contact operation is required only at the ends of travel is shown in Fig. 8. If the required interlocking is more involved, necessitating limit switch contact operation at various points during the travel, a multi-circuit type of switch, such as shown in Fig. 9, could be used. Each circuit can be adjusted to operate independently at any point of the switch travel. Geared limit switches should be used only if the motor is positively geared to the driven machinery, so that there is no slippage.

A problem often arises where a control function is to be initiated when the work inside the furnace reaches a certain position. Since it is difficult to arrange a limit switch to be actuated by the hot work, photoelectric relays are often used to determine the location of work inside the furnace. The active part of a photoelectric relay is the phototube, which has a cathode with a special light-sensitive surface. The cathode emits electrons upon being struck by light, and the resultant current is amplified electronically and used to actuate a relay which in turn provides the proper signal to the magnetic motor control.

Fig. 10 shows a front view of a simple photoelectric relay which has been widely used on furnaces for temperatures up to 1900 deg. F. This relay has an opening in the cover through which a light beam may strike the phototube. For work at higher temperature, special relays with an optical system and with special phototubes must be used to obtain reliable operations.

To act as a limit switch, the photoelectric relay is used in the following manner: A light source and a relay are mounted on opposite sides of the furnace and the light beam is trained on the phototube. As long as light from the light source strikes the phototube of the relay, the tube emits electrons and the relay is energized. When the work in the furnace intercepts the light beam, the phototube ceases to pass current and the relay is deenergized, thus providing the magnetic control with a signal that the work in the furnace has reached a certain point in its travel.

Operator's Panels

As long as a furnace contains only one or a few motorized drives, such as one or two doors, a conveyor, a fan, a roll drive, or the like, it is quite satisfactory to mount the push buttons or control switches for operating the motors directly on or adjacent to the furnace, close to the respective drives. When a number of drives are involved, such an arrangement would be rather confusing to the operator. It is preferable to group all control switches on one strategically located panel from which all mechanical drives can be operated and supervised. A very satisfactory arrangement is illustrated in Fig. 11. The temperature control instrument panels and the motor control panel for a roller hearth furnace are lined up to form a dead-front control board containing all the instruments and switches needed by the operator.

On very large furnaces it may be impossible to operate all equipment from one location. Several operators may be involved, each taking care of a section of the furnace. In such a case it is advantageous to subdivide the control switches in groups and arrange them on several control panels, each serving a section of the furnace. Referring back to Fig. 8, an operator's panel can be seen at the left of the instrument panel. This panel is mounted on a building column. The front is hinged to permit access to the switches and the wiring, and its purpose is to control one section of a roller hearth furnace.

In conclusion, it should be emphasized again that electric furnaces offer a wide field of application to magnetic control, both for controlling the furnace temperature and the motors associated with the furnaces, and that careful consideration should be given to the overall layout of the control when planning the details of a particular furnace installation. The following points are of major importance and should be carefully investigated:

1. First cost of the control, including cost of installation and field wiring.
2. Convenience of layout to the furnace operator.
3. Convenience of layout to the maintenance crew.
4. Safety to the operating personnel.

Fig. 11. Control center for operation of a roller hearth furnace.

A Materials-and-Methods Article High speed production of threads by rolling is a modern development that matches the fast production of cold-headed blanks described by Mr. Chase in an article in our August 1943 issue. But the calculation of blank diameters for different materials, types of part (screw, stud, tap, etc.), fits, etc. is a complex problem, and in this article Mr. Taylor offers formulas and tables to aid the designer in his planning.

Thread rolling is frequently applied to parts not made on the screw machine, such as the cold-headed parts shown here. Some of the threads in this picture have been rolled and some cut.

Rolled Threads Materials and Blank Diameter Calculations

by WILLIAM T. TAYLOR

THREE SCREW-THREAD PRODUCTION METHODS are in general use at the present time, namely: cut, ground and rolled. A thread-grinding machine can normally produce small sizes up to about 20 pieces per hr. without burning the threads, whereas the modern automatic thread-rolling machine can produce nearly 2,000 pieces of the same size in the same time, and approximately 3-times this number per hr. in ordinary screw thread stock.

Ground and cut threads are produced from stock of the same outside diameter as the outside thread-diameter regardless of the pitch of thread and class of metal, whereas the outside diameter of rolled-thread stock is always less than the outside thread (O.D.) size and the correct stock diameter is always dependent upon the thread pitch, the class and nature of metal used.

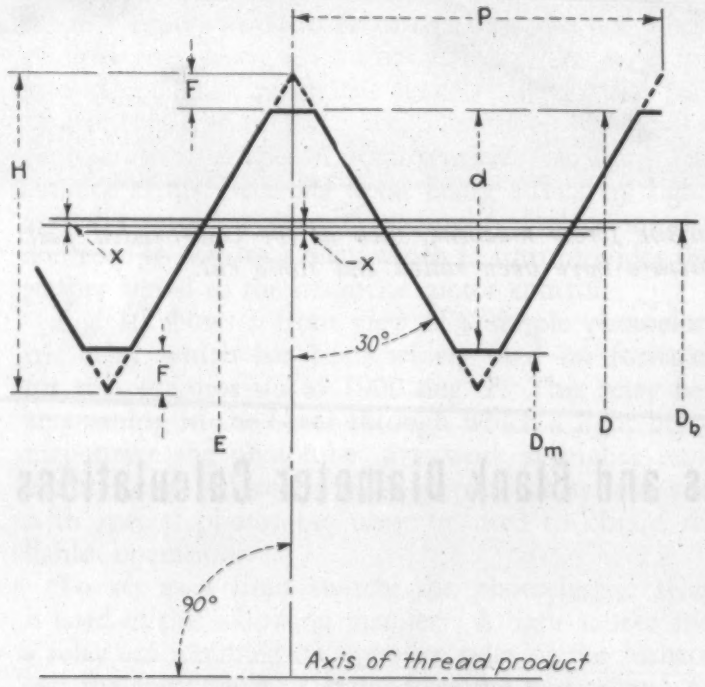
Material at the surface of a blank is forced by movement and pressure of the dies to "flow" from the approximate pitch line in a wavy form. The outer part of the rolled thread consists of the same material as the outer part of the original plain round blank, and the material nearest to the surface of the round blank is thrown up to form the outer wall and crest of the thread.

In the rolled-thread process no stock is cut away and wasted in making the screw thread; the finished thread has a smoother surface, and is made stronger and tougher due to forging the material and retaining the full length of grain or fibre. Texture and density of the material is improved, and the finished thread offers greater resistance to wear and fatigue. The rolled thread can be made to closer tolerances than cut threads, and nearly as close as ground threads; moreover, screw threads can be rolled in metals not commercially practical for cut threads.

The principal requirement for making accurate rolled thread to the required dimensions is to have just the right amount of metal, which depends upon several factors, such as the thread pitch, nature (including hardness) of metal, condition of surface of blank, the type of product (tap, aircraft stud, bolt, screw), and the class of fit (4, 3, 2 and 1).

Materials for Rolled-Thread Parts

A capable rolled-thread machine operator is usually able to produce a satisfactory screw thread from a not-too-oversize and a not-too-undersize blank—the allowance margin being very slight for a given set-up, precision limits and small sizes. But for best results there are limits of blank diameter and the main object of this article is to present a simple formula for blank diameter based on the pitch or the depth of thread, the basic pitch diameter, and a constant that changes with the nature of metal and the class of fit. Contrary to general belief the blank diameter for high speed steel should be greater (not smaller) than for carbon steel, i.e. high Rockwell and tough alloys or extra density require larger blank diameter; they are subjected to greater die pressure than carbon steel or screw stock.



The American National 60° thread form.

Rolled-thread material consists of both ferrous and non-ferrous metals such as high speed steel, high-carbon high-alloy steel, high-carbon stainless steel, stainless steel, carbon steel, aluminum, brass and other non-ferrous metals, Monel metal and other alloys that are commercially difficult to machine. In fact in any metal in which it is possible to commercially cut screw thread, and many tenacious metals in which it is not practical to commercially cut screw thread it is practical to roll threads. Many grades of alloy steels and carbon stock are well suited to cold forging and can be extensively worked.

Carbon steels are still extensively used in the manufacture of screw thread *taps*. Carbon steels are as tough and sometimes tougher than many alloy steels, including high-speed steel. After the thread is rolled it is hardened to a Rockwell not less than C-59 and not higher than C-64. The lead and diameters can be controlled to within precision limits.

Carbon steel taps are used on production tapping as well as general service tapping. High-speed-steel and high-carbon high-alloy steel ground thread taps are used on production tapping because they depend on speed for best results, and, as the threads and blanks are *ground,* tapping can be held to much closer accuracy than cut thread taps. The alloying elements of some alloy steels may be as high as 30 per cent. The alloy makes the metal better able to resist excessive heat, wear and abrasion, and the hardness is retained. Carbon steels, high-speed-steels and other alloy steels are all successfully used in the manufacture of taps by the rolled-thread process.

Effect of Pitch Diameter

It is evident from formula (1) below for blank diameter-factor x that two of the three principal thread elements are involved, namely the depth of thread d and the pitch diameter E, (y being a constant vary-

Table I. Constants for American National 60° Thread.

Sizes		*t.p.i.*	*Pitch*	*Thread Depth*	*Pitch diameter (E)*		*(0.649519P)²/E=x'*	
NC	*NF*	*(n)*	*(P)*	*(d)*	*NC*	*NF*	*NC*	*NF*
5	6	40	0.02500	0.016237	0.1088	0.1218	0.002426	0.002160
6	10	32	0.03125	0.020297	0.1177	0.1697	0.003500	0.002420
—	12	28	0.03571	0.023197	——	0.1928	——	0.002370
—	1/4	28	0.03571	0.023197	——	0.2268	——	0.002370
10	5/16	24	0.04167	0.027063	0.1629	0.2854	0.004490	0.002530
—	3/8	24	0.04167	0.027063	——	0.3479	——	0.002110
1/4	7/16	20	0.05000	0.032475	0.2175	0.4050	0.004850	0.002600
—	1/2	20	0.05000	0.032475	——	0.4675	——	0.002130
5/16	9/16	18	0.05556	0.036086	0.2764	0.5264	0.004710	0.002740
—	5/8	18	0.05556	0.036086	——	0.5889	——	0.002210
3/8	3/4	16	0.06250	0.040595	0.3344	0.7094	0.004905	0.002320
7/16	7/8	14	0.07143	0.046394	0.3911	0.8286	0.005503	0.002470
—	1.0	14	0.07143	0.046394	——	0.9536	——	0.002460
1/2	—	13	0.07692	0.049963	0.4500	——	0.005540	——
9/16	—	12	0.08333	0.054127	0.5084	——	0.005760	——
5/8	—	11	0.09091	0.059046	0.5660	——	0.005640	——
3/4	—	10	0.10000	0.064952	0.6850	——	0.006160	——
7/8	—	9	0.11111	0.072168	0.8028	——	0.006480	——
1.0	—	8	0.12500	0.081189	0.9188	——	0.007170	——

ing with the material and class of fit). Certainly the pitch diameter can be regarded as the most important of the three major thread elements. Not only does the pitch diameter control size, it is the determining factor of the mechanical strength of a screw thread though general belief still exists that the strength of a screw thread depends principally on the fit—one class of fit being closer or looser than another. Actually the mechanical strength of a screw thread is dependent upon the area of flank contact of the threads and the pitch diameter which (with d) form two of the principal basic factors of reference for blank diameter. The thread element d is a function of the thread pitch P.

The more accurate the pitch of thread P the more closely can the pitch diameter approach its theoretical or basic value, which is the *simple* pitch diameter and is best defined as the value of pitch diameter obtained by the well known method of measuring with wires the diameters of which are so chosen as to make contact at or very close to the pitch line. The basic or simple pitch diameter is $E = D - d$. It is equivalent to the pitch line dimension. Actual overwire measurement E′ is computed by formulae: $E' = M - (1 + \text{cosecant phi} \times P/2) - (\text{cotangent phi } 2n)$. This measurement takes no account of errors which may be present in the pitch P or the angle phi. The *compound* pitch diameter $E'' = E \pm$ limits, and it refers to the pitch diameter over a specified length of thread; it is greater or smaller than basic pitch diameter E due to the class of product (tap or screw) and class of fit and the errors in pitch and angle of thread. Allowable limits on E ensures that errors in P and/or phi do not impair the mechanical strength of the thread.

The blank diameter-factor is given by

$$x = d^2/yE \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

For $y = 1.0$, then $x' = d^2/E$, and for other values of y

$$x = x'/y \quad \ldots\ldots\ldots\ldots\ldots\ldots (1a)$$

The blank diameter is

$D(b) = E \pm x$ (plus for *taps*, minus for *screws*, studs) $\ldots\ldots (2)$

wherein $x = (0.649519\ P)^2/yE$ for American National 60° thread form; y = Constant, varying with the metal and class of fit, etc.; thus, for

(Screws, bolts, studs) using carbon steel		*(Taps) using carbon steel*	
Class of fit (2)	*Class of fit (3)*	*Class of fit (2)*	*Class of fit (3)*
NC 1.85	NC 3.55	NC 1.11	NC 1.23
NF 1.28	NF 1.61	NF 0.51	NF 0.56
		BSW 1.19	BSW 1.30
		BSF 0.77	BSF 0.86

The smaller the screw size the greater the thread depth d proportion. Thus, for a ¼ in.-20-NC the basic depth of thread d is 0.03248 in. (see Table I), hence the percentage relation 2d to the basic major diameter D is (2 x 0.032475/0.250) x 100 = 26%. And for a ½ in.-13-NC the depth of thread is 0.049963 in., hence the relation of double depth of thread to basic major diameter is (2 x 0.049963/0.500) x 100 = 20%. However, for a ¼ in. -28-NF the basic depth of thread d is 0.023197 in., hence the percentage double depth to basic major diameter D is (2 x 0.023197/0.250) x 100 = 19% only, and for a ½ in. -20-NF the depth of thread is 0.032475 in., hence the percentage relation of double depth of thread to basic major diameter is (2 x 0.032475/0.500) x 100 = 13% only. We thus see that as the thread-depth-proportion increases, a still greater decrease is effected in the thread area of metal.

Effects of Material and Tolerances

For screws of class 2 and 3 fits the basic pitch diameter is larger than the blank diameter, and for taps of class 2 and 3 fits the basic pitch diameter is smaller than the blank diameter. For example: the basic pitch diameter of a carbon steel ¼ in.-20-NC-2 screw is 0.2175 in. and the blank diameter is 0.2140 in., whereas the basic pitch diameter of a carbon steel ¼ in.-20-NC-2 hand tap is 0.2175 in. and the blank diameter is 0.2221 in. For the same size of screw and same class of fit, a low carbon steel may require a slightly different blank diameter as compared to a high carbon steel.

The tolerance for a ¼ in.-20-NC-2 and a ½ in.-20-NF-2 is equal to 0.0036 in. for both sizes, yet the basic pitch diameter E for the former is 0.2175 in. and 0.4675 in. for the latter. For carbon steel of approximately C-25 Rockwell hardness the blank diameter-factor x for the former is 0.00485/1.85 = 0.00262 in., and for the latter it is 0.00213/1.28 = 0.00166 in. Standard *minus* tolerance for both sizes is 0.0036 in. on both basic and maximum pitch diameters for class 2 fit; the required pitch diameter is given in the accompanying formulation.

(¼ in.-20-NC-2)	(½ in.-20-NF-2)
E=0.2175 in. (max.)	E=0.4675 in. (max.)
—0.0036 in.	—0.0036 in.
E″=0.2139 in. (min.)	E″=0.4639 in. (min.)
and the required blank diameter is	
E=0.2175 in.	E=0.4675 in.
—0.0026 in.	—0.00166 in.
D(b)=0.2149 in.	D(b)=0.46584 in.

For the ¼ in.-20-NC thread the tolerance in the major diameter D for a class 2 fit (and class 3) is from 0.2500 in. down to 0.2428 in. so that the blank diameter which applies for a commercial stud or bolt might work from a minimum of 0.2150 in. to 0.2165 in. max. and with a perfect set of dies we should obtain all the results required except perhaps the maximum major diameter which would vary with the size of blank started with. In order to roll to the correct size the dies should be of the required fit and they should be set to roll to the particular blank dimension.

Thus, for a ¼ in.-20-NC-2 the dies may be set to roll 0.21575 in. blank to middle point of class 3 limits; blanks of 0.2150 in. or 0.2160 in. should roll in the same die setting and stay within class 3 limit and thus satisfy class 2 at no greater cost for a better fit. The thread crests should be within limits for 0.2160 in. but may not be rolled full-form on the 0.2150 in. size.

Table II. Allowable Tolerances on the American National 60° Thread Screw.

Size		tpi	Pitch Diameters for different class of fit									Lead tol.		Angle tol.	
			Max.	Min.	Tol.	Max.	Min.	Tol.	Max.	Min.	Tol.	Class of fit			
NC	NF	n	Class 2 fit			Class 3 fit			Class 4 fit			2	3	2	3
—	10	32	0.1697	0.1670	0.0027	0.1697	0.1678	0.0019	—	—	—	0.0008	0.0005	1°39″	1°10″
6	—	32	0.1677	0.1650	0.0027	0.1677	0.1658	0.0019	—	—	—	0.0008	0.0005	1°39″	1°10″
—	12	28	0.1928	0.1897	0.0031	0.1928	0.1906	0.0022	—	—	—	0.0009	0.0006	1°39″	1°10″
—	1/4	28	0.2268	0.2237	0.0031	0.2268	0.2246	0.0022	0.2270	0.2259	0.0011	0.0010	—	1°30″	—
10	—	24	0.1629	0.1596	0.0033	0.1629	0.1605	0.0024	—	—	—	—	0.0007	—	1°06″
—	5/16	24	0.2854	0.2821	0.0033	0.2854	0.2830	0.0024	0.2857	0.2845	0.0012	0.0010	—	1°22″	—
—	3/8	24	0.3479	0.3446	0.0033	0.3479	0.3455	0.0024	0.3482	0.3470	0.0012	—	—	—	—
1/4	—	20	0.2175	0.2139	0.0036	0.2175	0.2149	0.0026	0.2178	0.2165	0.0013	0.0010	0.0008	1°28″	1°00″
—	7/16	20	0.4050	0.4014	0.0036	0.4050	0.4024	0.0026	0.4053	0.4040	0.0013	—	—	—	—
—	1/2	20	0.4675	0.4639	0.0036	0.4675	0.4649	0.0026	0.4678	0.4665	0.0013	0.0010	—	1°22″	—
5/16	—	18	0.2764	0.2723	0.0041	0.2764	0.2734	0.0030	0.2767	0.2752	0.0015	0.0012	0.0009	1°25″	1°02″
—	9/16	18	0.5264	0.5223	0.0041	0.5264	0.5234	0.0030	0.5267	0.5252	0.0015	—	—	—	—
—	5/8	18	0.5889	0.5848	0.0041	0.5889	0.5859	0.0030	0.5892	0.5877	0.0015	0.0009	—	1°02″	—
3/8	—	16	0.3344	0.3299	0.0045	0.3344	0.3312	0.0032	0.3348	0.3332	0.0016	0.0013	0.0009	1°22″	0°59″
—	3/4	16	0.7094	0.7049	0.0045	0.7094	0.7062	0.0032	0.7098	0.7082	0.0016	—	—	—	—
7/16	—	14	0.3911	0.3862	0.0049	0.3911	0.3875	0.0036	0.3915	0.3897	0.0018	0.0014	0.0010	1°19″	0°58″
—	7/8	14	0.8286	0.8237	0.0049	0.8286	0.8250	0.0036	0.8290	0.8272	0.0018	—	—	—	—
—	1.0	14	0.9536	0.9487	0.0049	0.9536	0.9500	0.0036	0.9540	0.9522	0.0018	0.0010	—	0°59″	—
1/2	—	13	0.4500	0.4448	0.0052	0.4500	0.4463	0.0037	0.4504	0.4485	0.0019	0.0015	0.0011	1°17″	0°55″
9/16	—	12	0.5084	0.5028	0.0056	0.5084	0.5044	0.0040	0.5089	0.5069	0.0020	0.0016	0.0012	1°17″	0°55″
5/8	—	11	0.5660	0.5601	0.0059	0.5660	0.5618	0.0042	0.5665	0.5644	0.0021	0.0017	0.0012	1°17″	0°53″
3/4	—	10	0.6850	0.6786	0.0068	0.6850	0.6805	0.0045	0.6856	0.6833	0.0023	0.0018	0.0013	1°13″	0°52″
7/8	—	9	0.8028	0.7958	0.0070	0.8028	0.7979	0.0049	0.8034	0.8010	0.0024	0.0020	0.0014	1°20″	0°51″
1.0	—	8	0.9188	0.9112	0.0076	0.9188	0.9134	0.0054	0.9195	0.9168	0.0027	0.0022	0.0016	1°10″	0°50″

Where the blank diameter is oversize for a screw (stud or bolt) the class of fit is better (improved), and *vice versa* for undersized blank. Depending on the class of fit and the product, the difference can, if not too great, be better cared for than in the case of a close tolerance aircraft stud. The constant y is sensitive to any change in the pitch of thread or change in blank diameter due to any cause such as that caused by the metal (brass, aluminum or carbon steel) which require different blank diameters for the same class of fit. Thus, a ¼ in. -20-NC-2 screw of low or high carbon steel rolled-thread requires a larger blank diameter than a ¼ in.-20-NC-2 rolled-thread brass screw; also, a ¼ in.-20-NC-3 carbon steel rolled-thread screw requires a larger blank diameter than a ¼ in.-20-NC-2 carbon steel rolled-thread screw.

Taps with Rolled Threads

It is fully recognized at this stage of the art that considerably more research work must be done before high-speed-steel rolled-thread precision *taps* can guarantee thread dimensions for every batch of blanks run through the heat treatment for final hardness.

Whether cut, ground or rolled, the threads of taps are particularly susceptible to wear on the crests (the major diameter) of the threads. The minimum size on the major diameter usually provides a reasonable margin for wear of the crests—the upper limit provides for ample clearance between the crests and roots of mating threads. By avoiding contact at the crests or roots of the thread, the opposite flanks of the threads are allowed to make proper load-bearing contact when the connection is tightened.

The rolled-thread tap is given back-relief and may (if desired) be given a slight relief on the chamfered threads. Radial relief is lacking but it is less desirable on the more common sizes such as 9/16 in. and under; in fact, present day tendency is to reduce radial relief on the threads. Radial relief is usually dimensioned in relation to oversize, and oversize tap blanks are, as previously mentioned, to be guarded against.

The function of radial relief (not unlike that of back-relief) is to provide easier cutting action. Ground and cut thread taps of 5/16 in. diam. and smaller have no relief on the threads and a minimum relief on the chamfer, since better control of size-tapping is thus obtained. The cutting edges of rolled thread can, as desired, be given favorable hook, the land width can be proportioned, and the material subjected to special heat treatment sufficient to make the rolled-thread tap adaptable to production and general service tapping.

Millions of rolled-thread taps have been produced in this country, and today the *precision* rolled-thread tap is produced and guaranteed by several manufacturers. The accuracy of the thread to be cut is no doubt one of the principal determining factors in the choice between ground, cut and rolled thread taps; the other chief factors for choice are initial cost, strength, cutting life.

Carbon vs. High Speed Steel

For a given major diameter, pitch of thread and class of fit, a high-speed-steel requires a larger diameter of blank than a low or high-carbon steel blank. Experts do not as yet agree as to where and how the extra material of the high speed steel disperses. Some say the material is pushed endways and passes out at the sides of the dies. Due to the greater pressure required for an alloy-steel blank compared with a low-carbon blank, the material is forced to flow initially upwards on both sides then longitudinally before the die is completely filled and consequently a slightly larger blank diameter is required in order to maintain the required major diameter. The greater the die pressure for a given steel and hardness, the greater the effect on blank diameter—one tenth (0.0001 in.) may equal 20% of the allowable P.D. tolerance.

The blank diameter-factor x for high speed steel and high-carbon high-alloy steel will be different from that shown in the examples for carbon steel —for taps it will be increased. Taken as a general rule, carbon steels and alloy steels are used for rolled-thread *taps* but carbon steels and softer metals are used for *screws*. Under certain conditions a carbon-steel tap of Rockwell C-62 is superior to a similar high-speed-steel tap of Rockwell C-64, and practice indicates that some carbon steels are tougher than high speed steel.

Where the blank diameter is oversize for a tap the class of fit may be reckoned as reduced or made worse, and *vice versa* for an undersized blank. If not too great the difference can usually be cared for by the use of proper dies and a proper set-up. The constant y is sensitive to change in pitch of thread, showing fairly wide difference between NS, NF, and NC. It is also sensitive to changes from one class of fit to another.

For a given tap size it is usually better to use a smaller sized blank; thus, for a ½ in.-13-NC-2 carbon-steel rolled-thread hand tap a 0.4540 in. blank diameter may be used, but the manufacturer may for some reason or other want to use a 0.4535 in. or a 0.4530 in. blank diameter which is the range for a ½ in.-13-NC-3. We thus see, from the viewpoint of fit alone, we get the advantages of a maximum diametrical allowance of 0.001 in. to play with, a saving in metal and the offer of a better class of fit without any additional cost. This allowance represents a constant y difference of 1.11 to 1.21.

The allowable basic and maximum pitch diameter tolerance on a ¼ in.-20-NC-2 and a ½ in.-20-NF-2 tap is 0.0015 in. for both sizes. This class 2 fit is equivalent to a commercial-ground (CG) thread—see Table III. The relative *Standard* allowable pitch-diameter tolerance to blank diameter tolerance for a carbon steel is given at the left.

Table III shows a difference of 0.0005 in. between class 2 and 3 fits. For commercial-ground (CG) taps the minimum of class 2 can be taken as the maximum of class 3. It is obvious that the computed blank diameters given here permit of a diametrical dimensional margin of a few tenths; hence two values for y may be justified such as 1.21 to 1.23 for NC-3.

(¼ in.-20-NC-2-tap)	(½ in.-20-NF-2-tap)
E=0.2175 in. (min.) +0.0015 in.	E=0.4675 in. (min.) +0.0015 in.
E′=0.2190 in. (max.)	E′=0.4690 in. (max.)
And the required blank diameter	E=0.4675 in. basic P.D.
E=0.2175 in. basic P.D. x=0.0044 in.	x=0.0042 in.
D(b)=0.2219 in.	D(b)=0.4717 in.

(¼ in.-20-NC-3-tap)	(½ in.-20-NC-3-tap)
E=0.2175 in. (min.) +0.0010 in.	E=0.4675 in. (min.) +0.0010 in.
E′=0.2185 in. (max.)	E′=0.4685 in. (max.)
And the required blank diameter	
E=0.2175 in. basic P.D. x=0.0040 in.	E=0.4675 in. basic P.D. x=0.0038 in.
D(b)=0.2215 in.	D(b)=0.4713 in.

Some Examples

A few examples of typical blank-diameter calculation problems and how the tables and formulae in this article may be used to solve them follow:

Example 1: What is the blank diameter for a ½ in.-20-NF-3 carbon steel bolt?
Answer: From Table I, E=0.4675 in. and x′=0.00213 in.; therefore D(b)=0.4675—0.00213/1.61=0.4662 in.

Example 2: What blank diameter is required for a ¼ in.-20-NC-3 carbon steel stud?
Answer: From Table I, E=0.2175 in., and x′=0.00485 in., therefore D(b)=0.2175—0.00485/3.55=0.2162 in.

Example 3: What diameter of blank using carbon steel is required for a ½ in.-20-NF-3 hand tap?
Answer: From Table I, E=0.4675 in., x′=0.00213 in.; hence D(b)=0.4675+0.00213/0.56=0.4713 in.

Example 4: What diameter is required for a round ground-surface carbon-steel blank to be rolled to a ¾ in.-10-NC-2 (or CG) hand tap?
Answer: From Table I, E=0.6850 in., x′=0.00616 in.; hence D(b)=0.6850+0.00616/1.11=0.6905 in.

Table III. Pitch Diameter Tolerances and Fits for American National 60° and Whitworth 55° Taps.

Size	(n)		Basic P.D.	Class of fit			Size	(n)		Basic P.D.	Class of fit	
	NC	NF		2(CG)	3(CG)	4(PG)		BSW	BSF		Grade 2	Grade 1
1/4	20	—	0.2175	0.2190	0.2185	0.2175	1/4	20	—	0.2180	0.2201	0.2194
1/4	—	28	0.2268	0.2283	0.2273	——	1/4	—	26	0.2254	0.2275	0.2268
5/16	18	—	0.2764	0.2779	0.2774	0.2764	5/16	18	—	0.2769	0.2791	0.2784
5/16	—	24	0.2854	0.2869	0.2859	——	5/16	—	22	0.2834	0.2856	0.2849
3/8	16	—	0.3344	0.3359	0.3354	0.3344	3/8	16	—	0.3350	0.3373	0.3366
3/8	—	24	0.3479	0.3494	0.3484	——	3/8	—	20	0.3430	0.3453	0.3446
7/16	14	—	0.3911	0.3926	0.3921	0.3911	7/16	14	—	0.3918	0.3943	0.3937
7/16	—	20	0.4050	0.4065	0.4060	——	7/16	—	18	0.4019	0.4044	0.4039
1/2	13	—	0.4500	0.4515	0.4510	0.4500	1/2	12	—	0.4466	0.4492	0.4484
1/2	—	20	0.4675	0.4690	0.4685	——	1/2	—	16	0.4600	0.4626	0.4618
9/16	12	—	0.5084	0.5099	0.5099	0.5089	9/16	12	—	0.5091	0.5118	0.5109
9/16	—	18	0.5264	0.5279	0.5294	——	9/16	—	16	0.5225	0.5252	0.5243
5/8	11	—	0.5660	0.5676	0.5676	0.5666	5/8	11	—	0.5668	0.5696	0.5688
5/8	—	18	0.5880	0.5904	0.5899	——	5/8	—	14	0.5793	0.5821	0.5813
3/4	10	—	0.6850	0.6866	0.6866	0.6855	3/4	10	—	0.6860	0.6890	0.6881
3/4	—	16	0.7094	0.7109	0.7104	——	3/4	—	12	0.6966	0.6996	0.6987
7/8	9	—	0.8024	0.8050	0.8050	0.8038	7/8	9	—	0.8039	0.8071	0.8062
7/8	—	14	0.8286	0.8306	0.8296	——	7/8	—	11	0.8168	0.8200	0.8191
1.0	8	—	0.9188	0.9212	0.9212	0.0189	1.0	8	—	0.9200	0.9234	0.9224
1.0	—	14	0.9536	0.9556	0.9546	——	1.0	—	10	0.9360	0.9394	0.9384

(*Note:* Grade 1 and 2 of the Whitworth 55° thread are for ground-thread equivalent.)

A Materials-and-Methods Article **Few engineers realize the extent to which sprayed-on metals are employed as elements in original design and production, as distinct from repair and maintenance uses, and the promising field for metallizing as a production-design tool. Mr. Kunkler in describing some typical successful applications, features the materials-engineering aspects and the special service characteristics frequently provided by metallized parts.**

Metallizing—A Production Process

by **L. E. KUNKLER** *President, Metallizing Company of America*

Spraying a plastic turret cylinder with silver. A deposit of 0.015 in. of silver is coated on the plastic cylinder and then machined to size. In this application electroplating had failed to deposit a coating beyond 0.003 in. in thickness without breaking away.

THE WIDE USE AND ACCEPTANCE of metallizing for corrosion-protection and in maintenance and repair operations has inspired industry to explore the possibilities of the process for production applications. The war has taught us that American ingenuity can overcome even seemingly insurmountable production problems and in many cases metallizing has broken these bottlenecks to achieve better production at lower cost.

While many applications have been stimulated by the war, the production use of metallizing dates back as far as 1933 when one company manufacturing electrical equipment sprayed carbon resistors with copper. The method used at that time was as follows: The carbon resistors were put into trays by hand, then placed on a conveyor, metallized, turned over by hand and sprayed on the other side applying a ¼-in. wide coating of copper to the parts.

In 1934 a large mid-western refrigeration company set up a production line for coating evaporator tubes with zinc. A conveyor system was used for passing the tubes from the sand blast room where the spot to be metallized was sand blasted, to the metallizing department where an operator sprayed the prepared spot with zinc for corrosion prevention.

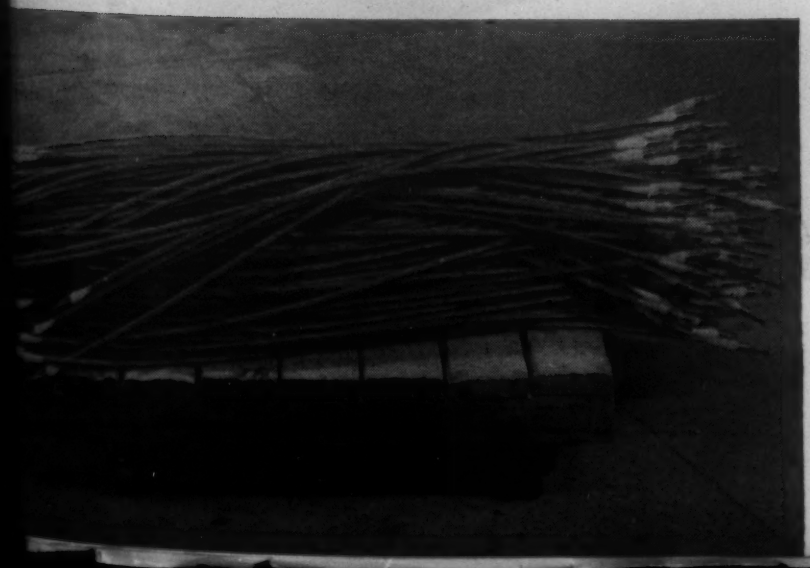
In 1935 spraying oil refinery tanks with zinc was set up on a production basis. The tanks, ranging in size from 50 to 70 feet in length and 8 to 10 feet in diameter were brought to the metallizing department by an overhead 90 ton crane conveyor and rested on rollers for sand blasting and coating. As one area was completed the rolls which were electrically controlled by a button switch were revolved, turning the tank to permit easy coating of all areas of the tank.

The above represents the advent of the production spraying era and up to the time of Pearl Harbor many manufacturers utilized the advantages of metallizing for coating parts of many descriptions. Since the war applications have multiplied, resulting in speeding up production, cutting costs and producing better products.

One application has suggested another and metallizing equipment manufacturers in many cases have worked closely with design and production engineers in developing production set-ups for metallizing operations.

The metallizing gun today is a very flexible piece of equipment, small, compact and engineered for continuous day-in and day-out use. It has been developed to spray any metal obtainable in wire form—to spray faster and produce denser and finer deposits so essential for successful jobs. Guns can be hand operated without operator fatigue—set up for lathe operation or mounted in a production line for automatic spraying. The guns operate on either propane, acetylene, natural or manufactured gases in conjunction with oxygen and compressed air.

A few of several thousand flexible casings which have been coated with zinc as a protection against corrosion. The coating is applied over a small area near the end of the casing where the flexible casing joins the end fittings.



For Corrosion and Heat-Resistant Parts

In these days of critical metal shortages one company producing pumps was confronted with the problem of obtaining stainless steel bar stock from which pump shafts could be turned. As a solution to this problem metallizing was adopted as a production method, spraying stainless steel on cold rolled steel shafts. The bearing and packing gland area were the only places along the shaft which were subject to severe wear and corrosive action of the liquids passing through the pump. This practice has resulted in a substantial saving in money and critical metal and has proven so successful that it will be continued long after the era of critical shortages has passed.

Applying coatings to parts subject to corrosion has been an important metallizing job due to the exceptional wearing qualities of zinc surfaces. Independent testing material laboratories have experimented making comparative tests with zinc coatings and galvanizing. Results showed that the life of zinc is dependent on the thickness of the coating and as the thickness of zinc deposit is doubled the potential life is four times as great as galvanizing.

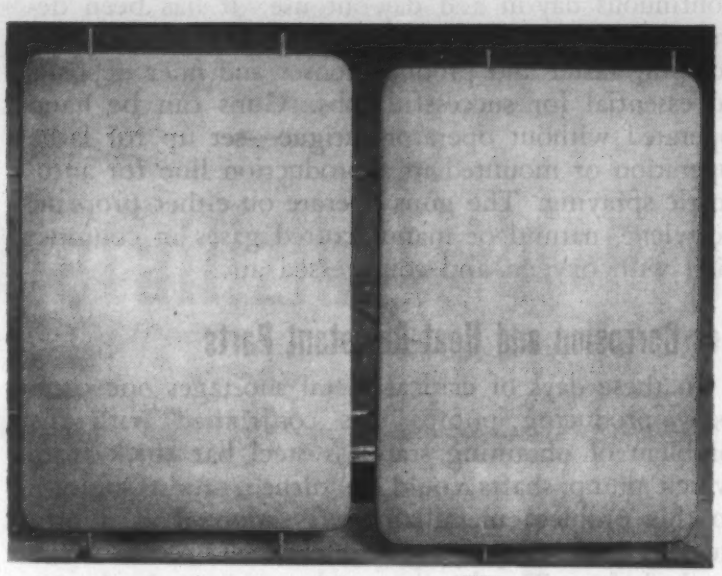
Many times large parts cannot be galvanized after fabrication on account of size; however this is no handicap when metallizing is used, for even the largest part can be easily sprayed. This is particularly true on dairy equipment where corrosion prevention is exceedingly important. Several manufacturers of this type of equipment are using metallizing for this purpose.

Metallizing surfaces with molten aluminum reduces the possibility of their scaling when exposed to intense temperatures. The life of pots used for pouring magnesium which are made from non-growing cast iron are being coated with 0.006 in. of aluminum giving added life and service to these pots.

Many companies are spraying welded seams on powder cans with zinc. Galvanized sheets are welded at the seams and the latter is then sprayed with zinc. This application is also in use at a large southern shipyard where zinc is sprayed on seams of galvanized fresh water tanks, chests and vent trunks where the galvanized coating has been damaged by the heat of welding.

Electrical Parts

Other production applications where metallizing has solved a problem include coating speed nuts with zinc, spraying condenser tape with zinc—spraying 0.002 in. of copper into the hole of carbon brushes, so that the connection can be soldered into the holes.



Flat plywood boards which have been sprayed with zinc and copper to obtain a metallic coating. These two members are then nested together to form a high frequency condenser.

The carbon brushes are also sprayed with copper to prevent the carbon from accumulating on the commutator and for better conductivity.

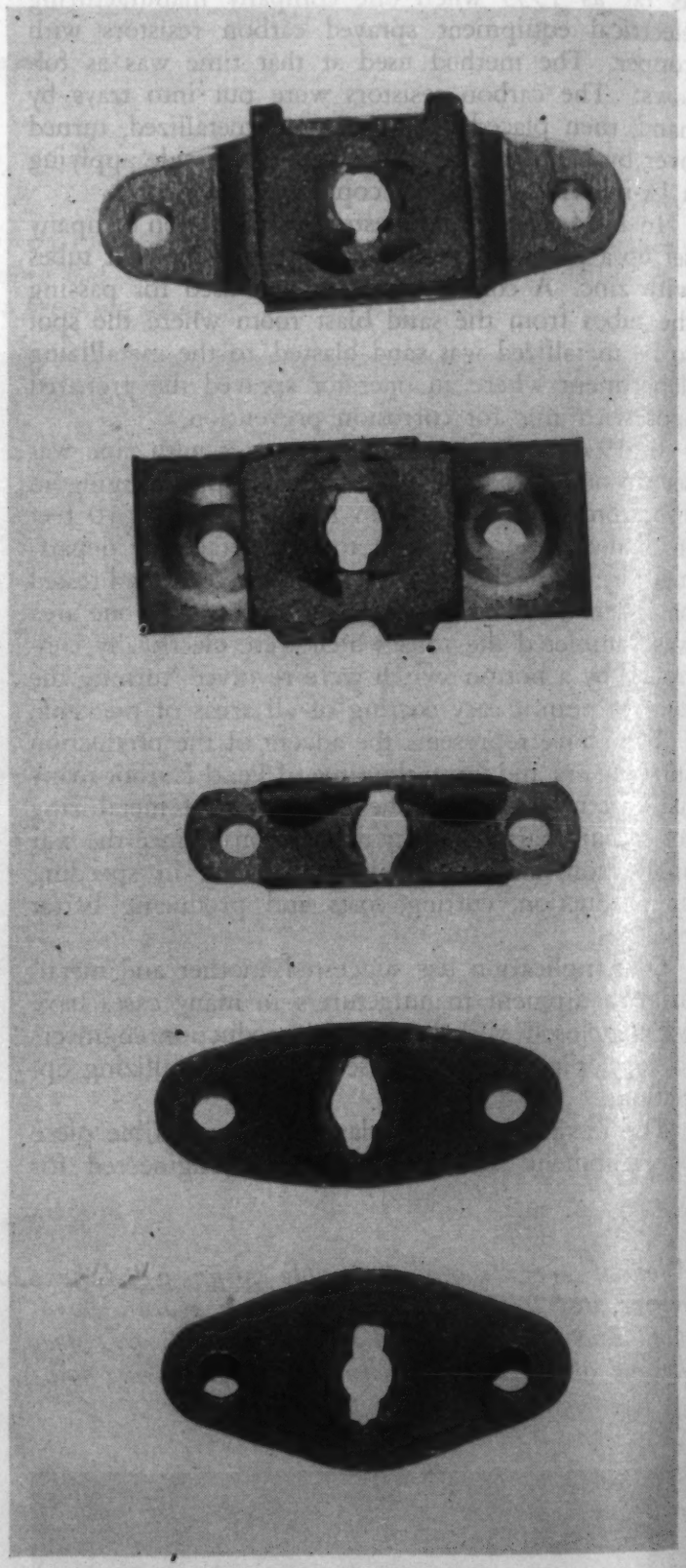
Another application which is unique and is used today in aircraft parts production is spraying the inside of a special clamp used to form a loop end on control cables. This small clamp is made of copper and is sprayed on the inside with Monel. The wires are passed through it and the clamp is squeezed together with a special crimping tool. The sprayed metal forms the locking points which hold the wire in place. This connection has proven so successful and possesses such unusual strength that the wire will break before the connection will let loose. This method, utilizing metallizing, has speeded up the manufacture of aircraft cables tremendously since the old method required at least 500% more time to complete.

Metallizing is used in radiography and X-ray for detecting defects in castings. One company is spraying lead on mandrels made of wood, which overcomes the disadvantage of the previous method of air pockets and seams on the mandrel. Another production application of spraying metal on wood is the case of flat plywood boards which have been coated with zinc and copper to obtain a metallic coating. Two members are then nested together to form a high frequency condenser. This method has proven most satisfactory and has saved many pounds of critical metal.

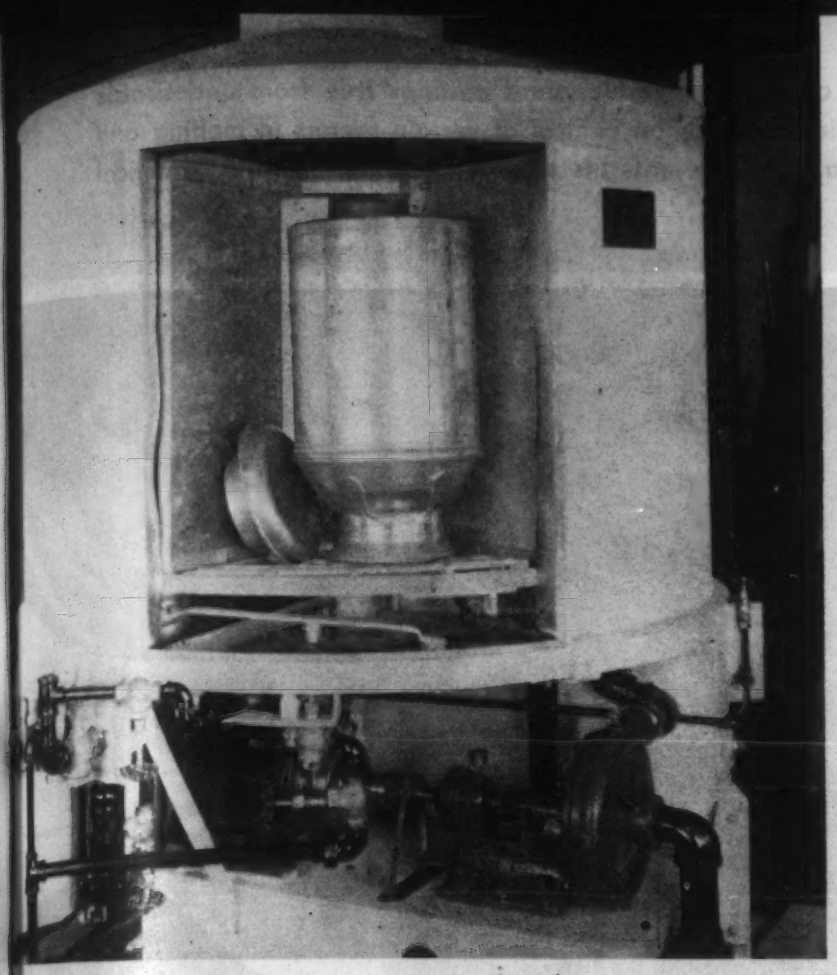
Bearing and Other Mechanical Uses

One company devised a method of spraying pistons with bronze which made possible a production run of 3,000 pistons per month. The piston is part of the hydraulic landing gear mechanism of one of the high altitude fighter planes. By spraying the wearing surface with bronze and making the body skeleton of steel, this company was actually able to obtain a stronger piston with half the weight of the previous solid bronze piston.

Another interesting application is spraying bearing area of turret tops with bronze. Before metallizing was used for this application a bronze ring was pressed into place on the steel turret top—metallizing was found to be faster, more economical and conserved critical metal. Several companies engaged



Spraying speed nuts with zinc to make them corrosion-resistant.



Many times large parts cannot be galvanized after fabrication due to size. This is no handicap however when metallizing is used. Illustration shows dairy equipment which is sprayed with zinc to make the equipment corrosion-resistant.

in the production of these turret tops adopted this bronze coating method successfully.

Plastic turret cylinders are also being sprayed with silver after electro plating had failed to produce a thickness beyond 0.003 in. without breaking away. With metallizing a deposit in 0.015 in. silver is coated on the plastic cylinder and then machined to size.

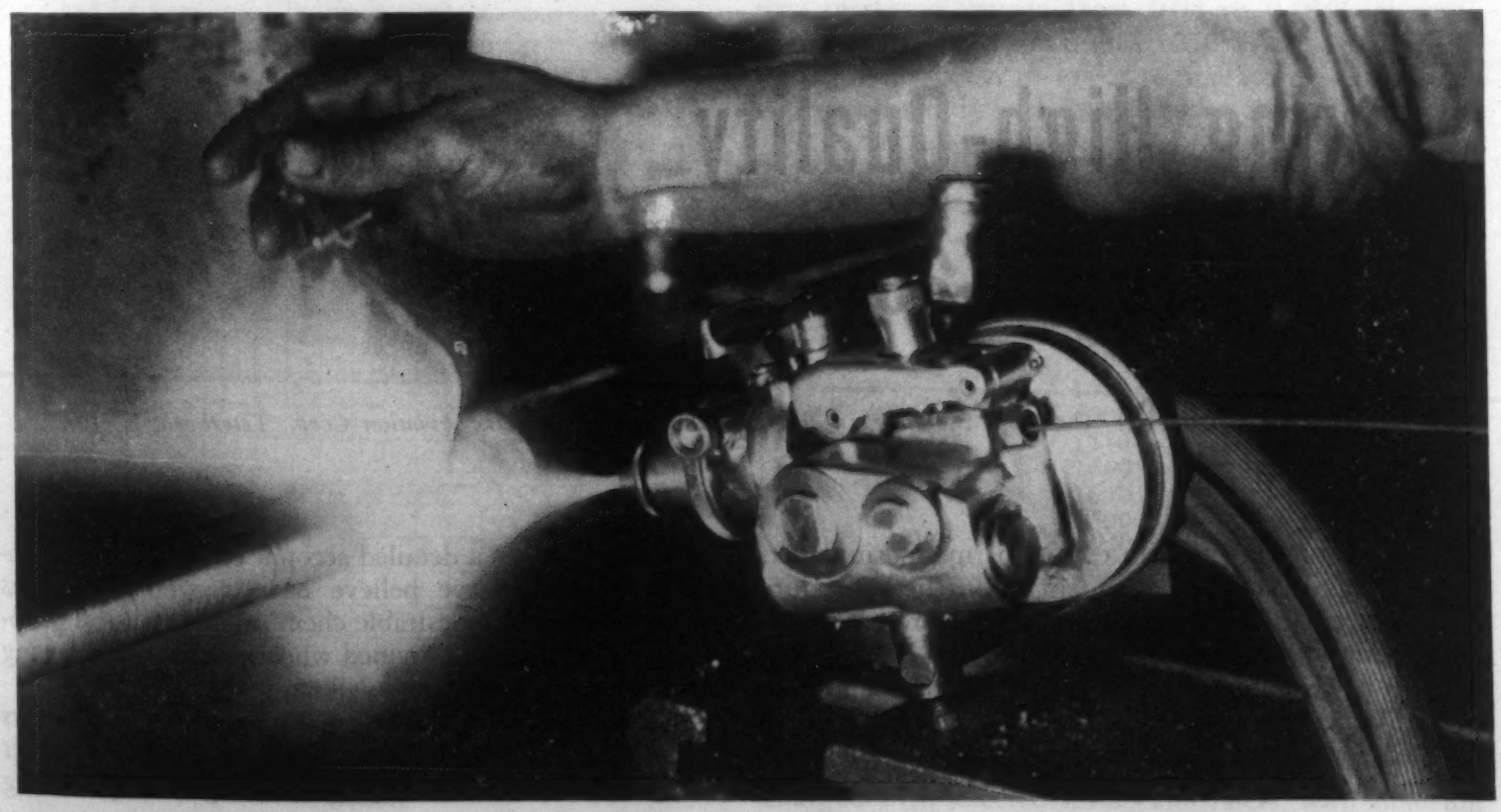
Metallizing production methods which plants have adopted include the use of conveyors, revolving tables and other automatically controlled devices for moving the parts to be coated in front of the metallizing gun. This article has been confined purposely to the applications of metallizing, rather than the mechanics of setting up methods, in the hope that it will suggest ideas to design and production engineers that will enable them to effect new economies and greater wearing qualities in the production of parts and products.

The vital production job metallizing is performing today is equal to the enviable record the process has achieved for reclaiming worn parts and salvage operations. The function of keeping equipment in operation and speeding production in thousands of plants throughout America promises even greater post-war use for this basic process.

Increased use of metallizing as a production method is the result of the many vital jobs that the equipment is performing successfully today.

In conclusion metallizing should be considered as a process for applying a metal coating mechanically bonded to a surface for corrosive prevention, heat resistance, weight saving, better conductivity of electrical parts, longer life, economical use of critical materials, and for applying a coating which can be tinned to a surface which otherwise could not be soldered. In addition, metallizing can be used for applying a coating to dies and molds and applying a metal surface to wood, plaster, plastic, ceramic and other non-metallic materials.

Cold rolled steel shafts sprayed with stainless steel on bearing and packing gland areas which are subject to wear and corrosion. Formerly shaft was made from solid stainless.



A Methods Article The production of high quality magnesium sand castings free from undesirable contaminations and possessing good physical properties depends on control of certain factors in melting and pouring. These Mr. Lorch has carefully investigated and he presents his experience in this helpful, practical article.

Fig. 1. Pouring a magnesium alloy sand casting, using mixture of sulphur and boric acid to prevent oxidation of the molten stream of metal.

Making High-Quality Magnesium Castings

by A. VERNON LORCH *Foundry Metallurgist, Eclipse-Pioneer Div., Bendix Aviation Corp., Teterboro, N. J.*

THE SUCCESSFUL PRODUCTION of magnesium alloy castings is largely dependent upon the procedures followed in the melting room. As a result of our experiences in melting magnesium sand casting alloys, it has become apparent that a number of foundry variables must of necessity be controlled very closely in order to minimize the occurrence of undesirable chemical and physical properties in castings. This article presents a detailed account of a number of procedures which we believe have proven themselves in preventing undesirable chemical and physical properties from being obtained when melting and pouring magnesium sand casting alloys.

Chemical specifications for magnesium base alloys are easier to maintain within limits than any other type of common foundry sand casting alloy, providing

careful melting practice is enforced. Some precautions must be taken to prevent contamination by other metals which may be present in the foundry, and also to prevent loss of alloying elements owing to segregation while melting. Silicon, lead, nickel, and aluminum are likely to be contaminating elements, while decreased manganese content is a possible result of segregation resulting from poor melting practice.

Avoiding Silicon Contamination

Silicon contamination is likely to occur in the most widely used sand casting alloys, ASTM B80-41T, Alloy 17, and ASTM B80-40T, Alloy 4, aluminum-zinc sand casting alloys of compositions indicated in Table I.

Table I. Chemical Requirements For Sand Cast Magnesium Alloys

Element	*ASTM B80-41T Alloy 17 (Eclipsaloy 56)*	*ASTM B80-40T Alloy 4 (Eclipsaloy 15A)*
Aluminum	8.30 - 9.70	5.30 - 6.70
Zinc	1.70 - 2.30	2.50 - 3.50
Silicon	0.30 max.	0.30 max.
Manganese	0.10 min.	0.15 min.
Copper	0.05 max.	0.05 max.
Nickel	0.01 max.	0.01 max.
Magnesium	Balance	Balance

The contamination is caused by chemical reduction of silica sand by molten magnesium. The presence of excessive silicon is indicated by a bluish tint on the surface of the castings, and by a mottled bluish appearance of any fractured section. The more intense the bluish tint, the greater the degree of silicon contamination.

This silicon contamination of magnesium-base alloys is wholly the result of poor melting technique, and can be prevented by close conformance to proper melting procedures. In order to definitely establish

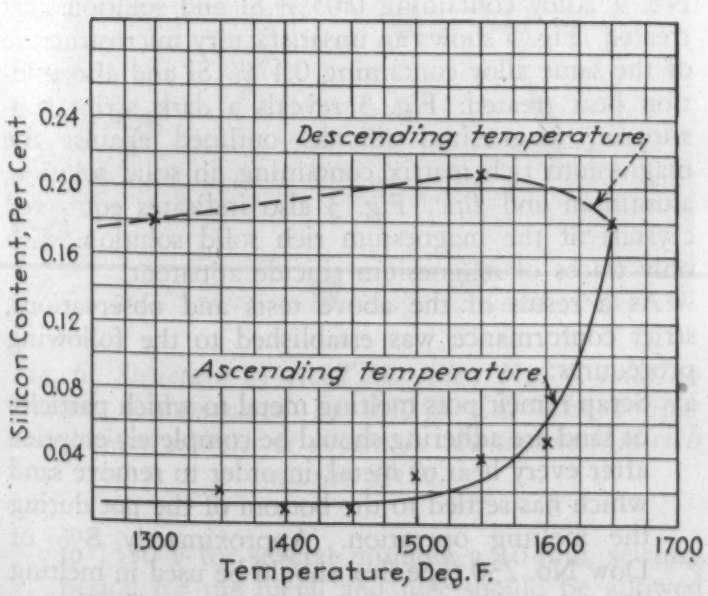


Fig. 2. Melting temperatures compared with silicon contents.

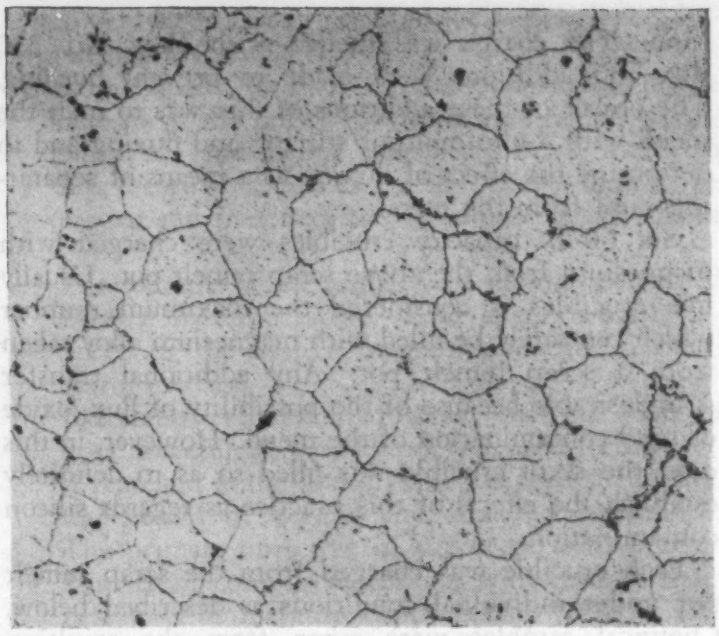


Fig. 3. Satisfactory microstructure of A.S.T.M. Alloy No. 4, solution treated, containing 0.05% Si. Note fine grained magnesium-rich matrix. 100X.

a correct melting procedure, it was necessary to obtain information of a detailed nature regarding the action of silica sand in molten magnesium, when sand comes in contact with the magnesium. Of course, the best prevention against silicon contamination is to eliminate the contact between sand and molten magnesium.

Tests were conducted to establish the temperature at which silica sand is chemically reduced and combined with the magnesium. The tests consisted of charging ½ lb. of silica sand and 30 lb. of ingot magnesium alloy into crucibles, melting the metal, and superheating to 1650 F, with samples being taken for chemical analysis at 50-deg. intervals of increasing and decreasing temperatures. Table II is a summary of these results. It will be noted that the silicon content increases sharply from 0.05 to 0.18% at temperatures between 1600 and 1650 F, and is retained as the metal cools to lower temperatures. This relation is also indicated in the curve shown in Fig. 2.

Table II. Silicon Content vs. Melting Temperature— ASTM No. 4 Alloy

Sample No.	*Temperature, Deg. F*	*Silicon content*
1	1350	0.02
2	1400	0.01
3	1450	0.01
4	1500	0.03
5	1550	0.04
6	1600	0.05
7	1650	0.18
8	1600	0.20
9	1550	0.21
10	1400	0.19
11	1350	0.185
12	1300	0.18

Further work was performed to determine the effect of improper melting practice on silicon contamination. A 500-lb. capacity scrap remelt pot was charged with selected sprues and risers, with adhering

sand. The charge was melted with Dow No. 230 flux and additions were made to prevent burning. The object of these additions of flux was to melt the metal with a minimum of stirring and fluxing and to determine the effect of fluxing as a means of separating sand from the metal.

Six 60-lb. capacity crucibles were charged with magnesium from the above scrap remelt pot. Usually five crucibles is considered the maximum number which can safely be filled with magnesium alloy taken from a scrap remelt pot. Any additional transfer is undesirable because of the possibility of flux, oxide or sand contamination of the metal. However, in this case, the sixth crucible was filled so as to definitely establish the effects of this practice as regards silicon contamination.

Each crucible was charged from the scrap remelt pot under individual conditions as described below. Chemical samples were taken from the resulting castings as they were made from the contents of each of the six crucibles. Each crucible had been superheated and cooled to the proper pouring temperature before casting.

Crucible No. — *Process*

1. Metal poured from scrap pot at 1130 F, 1 min. after stirring, no flux added to scrap pot.
2. Metal poured from scrap pot at 1200 F, no stirring, no flux added to scrap pot.
3. Metal poured from scrap pot immediately after thorough stirring and fluxing in scrap pot at approximately 1250 F.
4. Metal poured from scrap pot after allowing 5 min. for metal and flux to settle following stirring and fluxing mentioned above for Crucible No. 3.
5. Metal poured from scrap pot immediately after Crucible No. 4.
6. Metal poured from scrap pot immediately after Crucible No. 5.

Table III indicates the silicon analysis on castings made from each of the above crucibles.

Table III. Silicon Content vs. Scrap Remelt Pot Technique

Crucible No.	*Silicon %*
1	0.07
2	0.06
3	0.12
4	0.03
5	0.04
6	0.12

The low silicon content of castings poured from Crucibles Nos. 4 and 5 indicates that thorough fluxing, low scrap remelt temperatures and sufficient time for settling of flux and sand after stirring, can minimize silicon contamination which originates at the scrap pot and is carried over into the crucible furnace. Test No. 3 indicates that silicon contamination results from agitation of the melt without a waiting period, and Test No. 6, as expected, indicated

Fig. 4. General view of the melting section of magnesium alloy sand foundry. Molds travel on conveyors past the pouring station.

that removing too much metal from the scrap pot resulted in contamination of the last metal removed.

As a result of the above tests the following conclusions were obtained:

a. Sand which enters the melting system usually enters as adhering molding sand on scrap risers, gates, runners, and sprues, and as pieces or core sand which may not be thoroughly cleaned out of scrap castings having internal cores.
b. Silicon contamination may occur as a result of either of two conditions: (1) Direct charging of dirty scrap to a pot that will subsequently be superheated to above 1600 F. (2) Transfer of sand with metal when charging a superheating crucible from premelted scrap.
c. Substantially all sand entering the melting system can be removed at the scrap remelt pots by enforcing proper melting practice.
d. Chemical reduction of sand by magnesium and contamination of the magnesium alloy does not occur in appreciable amounts below temperatures of 1600 F. Above this temperature the molten magnesium reduces the silica sand, resulting in the formation of magnesium silicide, which, metallographically, appears as a bluish script constituent.

Fig. 3 shows a satisfactory microstructure for ASTM No. 4 Alloy containing 0.05% Si and solution heat treated. Fig. 5 shows an unsatisfactory microstructure of the same alloy containing 0.47% Si and also solution heat treated. Fig. 3 reveals a dark script constituent, magnesium silicide, outlined against the magnesium rich matrix containing, in solid solution, aluminum and zinc. Fig. 3 also indicates equi-axed crystals of the magnesium rich solid solution, with only traces of magnesium silicide apparent.

As a result of the above tests and observations, strict conformance was established to the following procedures:

a. Scrap remelt pots melting metal to which particles of sand are adhering should be completely emptied after every heat of metal, in order to remove sand which has settled to the bottom of the pot during the melting operation. Approximately 8% of Dow No. 230 type flux should be used in melting down each heat of scrap of this type. Clean scrap and ingot should require no more than half this amount of flux.
b. After stirring the flux through the melt at 1250

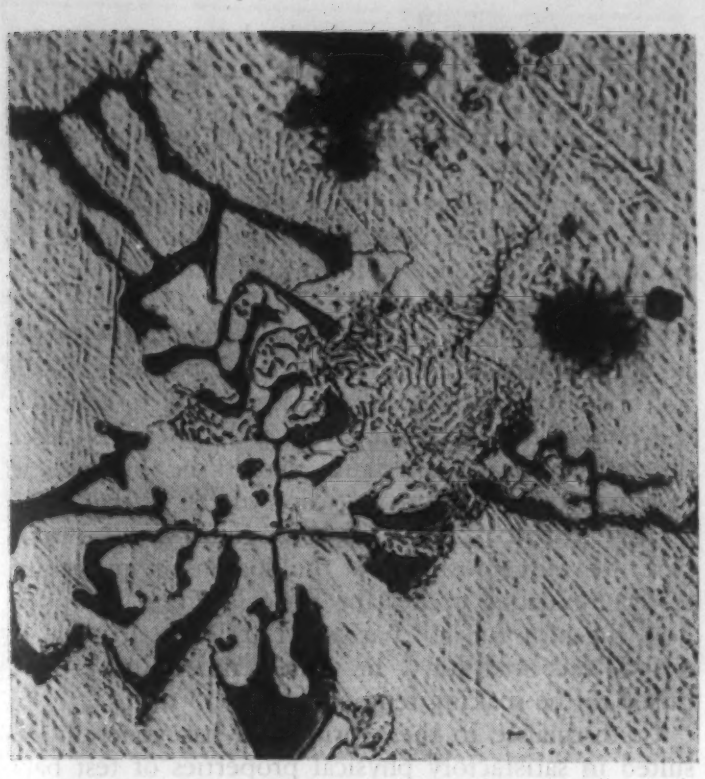


Fig. 5. Structure of A.S.T.M. Alloy No. 4, solution treated contaminated by 0.47% Si. The dark magnesium silicide script is shown in the light magnesium matrix. 350X.

Fig. 6. Structure of A.S.T.M. Alloy No. 4, solution treated, contaminated by 0.75% Cu. The copper magnesium eutectic is shown in the magnesium-rich matrix 350X.

to 1350 F for several minutes, a 10-min. settling period for the metal and flux should be allowed before any metal is ladled or poured from the remelt pots to superheating crucibles.

c. Metal should be transferred from the remelt pots to the superheating crucibles at temperatures between 1300 and 1400 F.

d. An adequate "heel" of metal should be left in the bottom of the remelt pot to minimize any possibility of sand being transferred with metal to superheating crucibles. The "heel" should be pigged and remelted in a subsequent scrap remelt pot.

e. The contents of the remelt pots should not exceed 1400 F in temperature. Sand is more easily reduced by the molten magnesium as the temperatures increase.

f. Extremely contaminated scrap, such as flash or floor sweepings, should not be used. However, if remelted in the foundry, each heat of such material should be pigged and analyzed before use. The primary objective in any event is to prevent sand from coming in contact with molten magnesium at temperatures approaching 1600 F. This requirement also implies careful crucible melting, with the proper precautions being taken to prevent sand from finding it's way directly to the crucibles, such as might occur if sand were to fall from overhead sand conveying structures, or if sand were present in ingot molds when metal is pigged.

g. The presence of sand in any melting pot is to be avoided, as contamination can occur only if sand is present.

The above recommendations are for the purpose of eliminating any difficulty resulting from sand which may inadvertently find its way into the melting system.

Control of Other Elements

Aluminum Contamination

Foundries melting and pouring both aluminum and magnesium alloys are confronted with the problem of preventing contamination due to mixed scrap. A recommended practice to aid in the prevention of this contamination is to color mark all gates, risers, sprues, and runners with a paint crayon to identify the alloys. The marking may be applied on the foundry floor any time after the metal solidifies. Miscellaneous non-marked material should be melted, pigged and analyzed before use in order to detect the presence of any contaminating elements. A great deal of metal and casting loss can be prevented by sorting all scrap material before it is used in the melting furnace.

Copper Contamination

Copper will alloy very readily with molten magnesium. The presence of copper will lower the corrosion resistance of magnesium alloys to such an extent that the maximum specified for copper is 0.05%. Contamination of magnesium by copper can be caused by remelting magnesium scrap having bronze chills adhering to the metal, or remelting scrap castings having bronze inserts. The possibility of contamination by bronze chills can be eliminated by using iron chills. The possibility of obtaining undesirable castings as a result of copper contamination from brass

or bronze inserts can be prevented by melting, pigging and analyzing all scrap which is likely to contain inserts, and using the metal thus obtained for castings only if it meets chemical requirements. Fig. 6 indicates a microstructure of a heat-treated ASTM No. 4 Alloy sand casting containing an excess copper, namely 0.75%. The copper-magnesium eutectic is shown in the magnesium rich matrix.

Lead Contamination

Lead will alloy very readily with molten magnesium, although it is allowable only to the extent of 0.05% maximum. In order to insure that lead contamination will not occur, it is recommended that lead core plugs be not used in any foundry casting magnesium alloys. These plugs have been known to become part of a melt of magnesium alloy when their use was not properly controlled.

Nickel Contamination

Nickel will alloy with magnesium which is in the molten state, although it is allowable only to the extent of 0.01% maximum. To prevent nickel contamination, it is necessary to prevent alloys containing nickel from coming in contact with magnesium. Melting pots, thermocouples and skimmers should be a non-nickel containing ferrous alloy. High nickel alloy thermocouples are quickly attacked by molten magnesium. However, some authorities believe 1% Ni is an allowable alloying element in steel used for processing molten magnesium. The presence of nickel in magnesium alloys is known to reduce corrosion resistance of magnesium alloys.

Manganese Loss

Manganese is alloyed in minor quantities with the common magnesium sand casting alloys because of its ability to assist in the corrosion resistant properties of the alloys. Since the innovation of large tilting type holding furnaces, large quantities of magnesium alloy may be held at low temperatures for long periods of time. If proper control, as indicated below, is not exercised, manganese will precipitate from the melt, with the result that the manganese content will be slightly below the minimum specification of 0.15% for ASTM No. 4 Alloy and 0.10% for ASTM No. 17 Alloy.

If the holding furnaces are to be used for continuous type melting operation, the temperature of the melt should be maintained between 1300 and 1350 F in order to prevent excessive precipitation of the manganese. Manganese loss is increased if temperatures are held below this range, inasmuch as the manganese increases in solubility in molten magnesium as the temperature increases. Some instances have been noted in which slag and flux removed from the bottom of improperly operated furnaces have revealed a manganese content as high as 0.15% after three days of continuous melting.

Obtaining Best Physical Properties

It is known that the best physical properties of magnesium sand cast alloy test samples are obtained from fine grained metal obtained by proper superheating practice in the melting furnace, and which has been properly heat treated.

It is recommended that the melt be superheated to a temperature of 1650 F and held for a period of 15 min. at that temperature. Cooling to pouring temperature should be as rapid as possible in order to preserve the tendency to form fine grain.

When heat treating ASTM No. 17 Alloy and ASTM No. 4 Alloy, the soaking temperatures should be maintained at 760 and 730 F respectively, for 10 to 16 hr. depending on section thickness. In addition, the rate of heating during which the metal is raised to the soaking temperature should be gradual, in order to prevent incipient fusion of the intergranular aluminum-zinc-magnesium compounds in the temperature range just below the soaking temperature. A recommended preheating cycle in either case is to hold the heat for 1 hr. at 550 F, raise in 15 min. to 640 F and hold for 1 hr. The temperature is then raised to the soaking temperature in 15 min.

Conformance to these principles has generally resulted in satisfactory physical properties of test bars. However, although proper melting and heat-treating procedures were in effect, several tensile test bars were tested which failed to meet the minimum tensile strength specified for the ASTM No. 4 and No. 17 Alloys.

Table IV. Physical Requirements For Sand Cast Magnesium Alloys

Property	*Minimum Required*			
	ASTM B80-41T Alloy 17 (Eclipsaloy 56)		*ASTM B80-40T Alloy 4 (Eclipsaloy 15A)*	
	Heat Treated	*Heat Treated & Aged*	*Heat Treated*	*Heat Treated & Aged*
Tensile strength, p.s.i.	30,000	34,000	32,000	34,000
Yield strength, p.s.i.	10,000	18,000	10,000	16,000
Elongation %	6.0	1.0	7.0	3.0
Brinell hardness @ 500 Kg.	50	70	48 - 60	65

The results were slightly below the minimum properties which are listed in Table IV. An investigation of melting and heat-treating practices, including checks of temperature control instruments, confirmed that both operations were being properly performed, and did not appear to be the cause of the poor results.

Investigation of the sand, pattern equipment, also gating and risering methods failed to disclose the cause of the test bar failures. However, it was noted that the test bars yielding poor physical tests invariably had an unusually rough surface. Further investigation disclosed that the rough surfaced test bars were cast in molds which were not rammed sufficiently hard.

The mold hardness of these soft molds was between zero and 20 A.F.A. Standard. On the other hand the mold hardness for molds which yielded

Fig. 7. Temperature control on melt of molten magnesium.

smooth surfaced test bars was in all cases between 40 and 60 A.F.A. Standard. Therefore, as the soft molds were unsatisfactory and resulted in unsatisfactory test bars, we have since maintained the mold surface hardness of all molds between 40 and 60, A.F.A. Standard. The resulting smooth test bars have been yielding very satisfactory results in physical tests.

The test bars with the rough surface revealed slight oxidation penetrating from their periphery to a depth of one to three thousandths of an inch into the test bars. This caused a "notch effect" on the surface of the test bar, resulting in reduced strength when the sample was subjected to tensile stress. Confirmation of this belief is the fact that poorest results were obtained in solution treated and aged test bars, which are known to be more sensitive to the notch effect than are test bars which were solution treated only. It was also noted that a slightly larger grain size resulted in the test bars poured into soft molds, probably due to a lesser chilling effect of the loosely packed sand in the mold.

Melting Furnace Maintenance

With the demand on productive capacity of magnesium extremely high, it is important that melting room operations be checked continually so as to reduce lost time to a minimum. Thermocouple equipment should be kept clean and well maintained in order to obtain quick and accurate response to temperature changes in the melt. Frequent checks should also be made on the rate of heating being obtained from the various melting furnaces. It is not uncommon for an improperly maintained furnace to indicate a rate of heating only 50% that of a properly maintained furnace. Burner settings and furnace construction should be checked and burners and furnaces kept clean, so that each furnace is operating at its maximum capacity, thus resulting in more pounds of metal melted per furnace. Furnace atmospheres should be checked chemically to obtain most efficient combustion and to increase pot life.

Adequate skimming and crucible cleaning equipment should be available to fit crucible contours and facilitate cleaning crucibles after pouring. Thermocouples should be checked periodically for accuracy, and repaired immediately if discrepancies are found Pyrometers should be enclosed in airtight boxes provided with positive air pressure to prevent fumes from corroding the instruments. The instruments will, as a consequence, yield longer and more accurate service.

Conclusions

A number of foundry variables must be closely controlled in order to successfully produce magnesium alloy sand castings.

Although chemical contents are relatively easy to maintain within the specified limits, some precautions must be taken to prevent contamination by other elements, and loss of alloy content owing to segregation. Silicon contamination results from contact of sand with molten magnesium at temperatures in excess of 1600 F. Lead, copper, nickel, and aluminum are easily alloyed with molten magnesium and should be carefully excluded from the magnesium foundry. Manganese content in magnesium alloys will tend to decrease if the melt is held below a temperature of 1300 F.

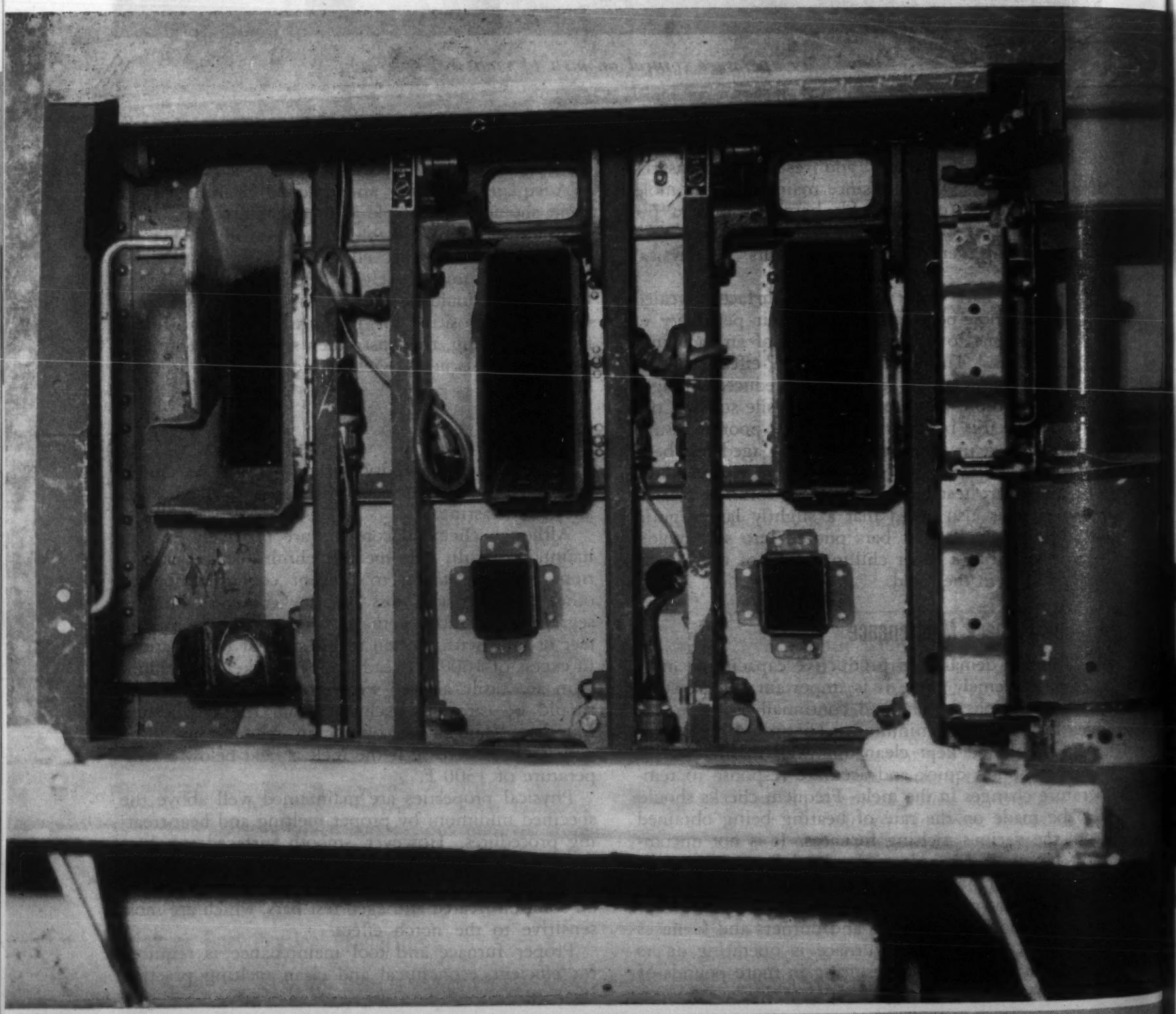
Physical properties are maintained well above the specified minimum by proper melting and heat-treating procedures. However, smooth surfaced test bars are also necessary for obtaining the best results. Rough surfaces introduce a "notch effect," especially on solution treated and aged test bars, which are most sensitive to the notch effect.

Proper furnace and tool maintenance is required for efficient, economical and clean melting practice.

Phenolic Fibre in Airplane Parts

by GERALD ELDRIDGE STEDMAN

The phenolic fibre injector chutes installed in the wing of a P-51 Mustang fighter, one for each of the three guns in each wing. From these open chutes, spent shells are ejected into the air.



A Materials Article Among the plastics for which wartime experience has prepared a promising postwar future are the phenolic fibres—basically cotton-base laminates impregnated with phenolic resins. Mr. Stedman discusses herein their characteristics, design features, fabricating behavior, etc., as exemplified in their application in several B-25 bomber parts.

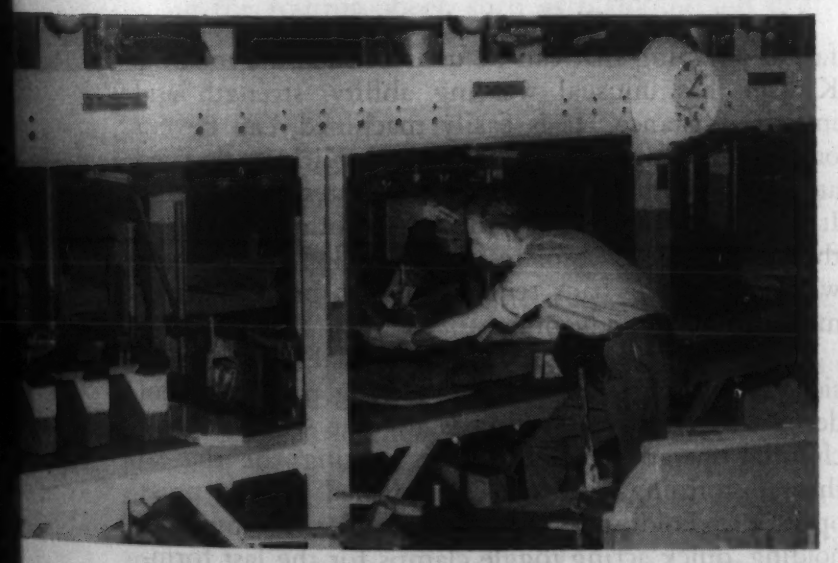
As THE B-25 MITCHELL sticks its lethal nose into the hornet's nest of combat over all the war fronts, it is interesting to know that better than 30% of all nose parts (or 60 in all) are formed from phenolic fibre. Carrying 14 machine guns and a cannon, the B-25 has more fire power than any other airplane of its class. London papers were full of its devastating invasion accomplishments.

North American Aviation, Inc., designers and constructors of the B-25 Mitchell, have perhaps gone further in the use of phenolic fibre parts than any other airplane manufacturer, particularly at its main Inglewood, California, plant. Ammunition chutes and buffers, cable and pulley guards, fairings, deflector plates, tail turret ejectors and curtain guides, protectors, fuselage channels and flooring, gunner seat back rests, emergency hatch covers and gun charger knuckle guards, are among the parts formed from this versatile material. Phenolic fibre is used also in the construction of many P-51 Mustang parts, the other military aircraft of North American design that has given such a signal account of itself in winning this war.

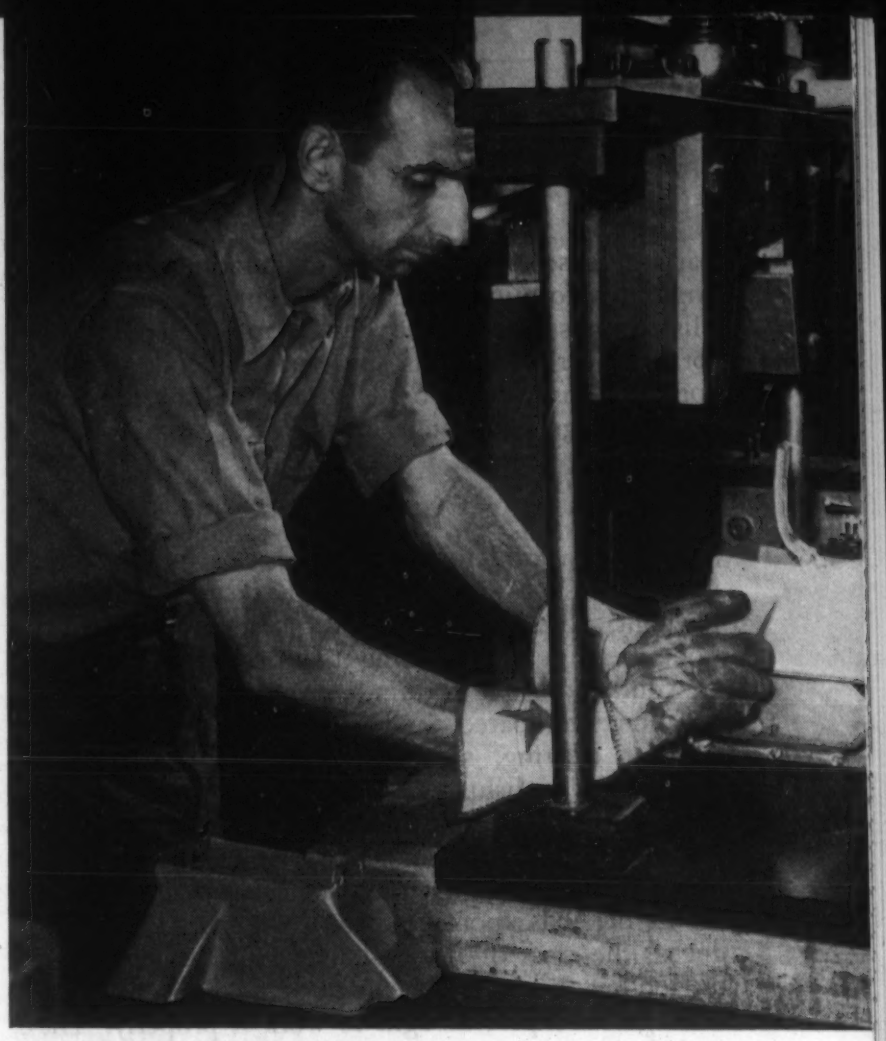
Phenolic fibres are used for so many formed parts in military airframes, not only because of the desire for weight reduction and saving in critical metals, but, more importantly perhaps, to avoid the abrasive hazards of metal-to-metal contact. Metal particles set afly as enemy air fire punctures a plane's enclosures in combat have fouled many a machine gun catastrophically.

Characteristics

The principle of resiliency is also involved. For example, it was years ago discovered that when a sandblast nozzle of chilled steel was used to direct a blasting stream of metal or sand shot, the nozzle would quickly wear away, but by coating it with rubber, the give of the rubber would increase the nozzle life twentyfold. It is the same principle as "rolling with the punch" in the ring or "giving with the catch" in baseball. So phenolic fibre ejector



An operator removes a phenolic part from the die after forming on the three-cylinder pneumatic press. A manually operated valve controls the press.



A phenolic part is being removed from the hydraulic press after forming.

chutes, catching the spent cartridge cases of the machine guns, last longer and do not foul the machine guns with drifting metal particles. In first designs, the ejector chutes were of metal, which, under the impact of the stream of metal cartridge cases being ejected, wore out to become clogged hazardously within a single strafing run. Needless combat accidents have been prevented and individual lives have been saved through the use of phenolic fibre parts.

Phenolic fibres come to the North American plant in flat sheet which has a cotton base, impregnated with phenolic resin, made by a considerable number of manufacturers and varying greatly in its characteristics and properties between the varied brands. Physical properties can be obtained from these base material manufacturers. Because of the variation in properties and characteristics, North American has originated its own standards and specifications with which all material must conform. There is a careful receiving inspection of it. One of the problems that makes its forming an art is this variability which an operator must sense to conduct proper forming. The important consideration is that the sheet, properly blanked, comes to the forming die about 98% cured and receives its last possible heat treatment in the forming operation. Any error in forming causes absolute waste of the product.

Phenolic fibre has little or no elongation. Its "spring back" in forming cannot be predetermined. All "dream ups" of its form design require "practical touch," because of the unusual number of variables in handling it. So, it is unusually important that there be close liaison between engineering and shop in its successful fabrication.

At present, this plastic is used on non-stressed

parts because of the material's limitations from that angle. In forming, it requires right heat or it will blister disastrously. Die design must consider the totality of requirements involved in bends, flanges, contours, and dimple beads to accomplish all phases of the design completely in one press stroke.

Design

The diemaking for phenolic fibre is in the softer materials, such as Masonite, Kirksite, maple or phenolic fibre itself. Because there is no elongation, there is no trimming required after forming. Of course, the one forming operation gives it great advantage compared to metal, in that it saves time in heat treating, straightening, trimming, buffing, burring and polishing. There will be a considerable field for it in the plastic age at the war's end, depending upon controlling its variables, the development of finer base materials and automatic forming. Its use depends upon the quantity of parts to be produced, the class of material used and the avoidance of tooling hazards. Phenolic fibre takes practical tooling and expert thought to work it properly. The tool design and its method of quick forming is all important. Better than 85% of North American Aviation's patterns are developed in its shop and are therefore blanked to proper size.

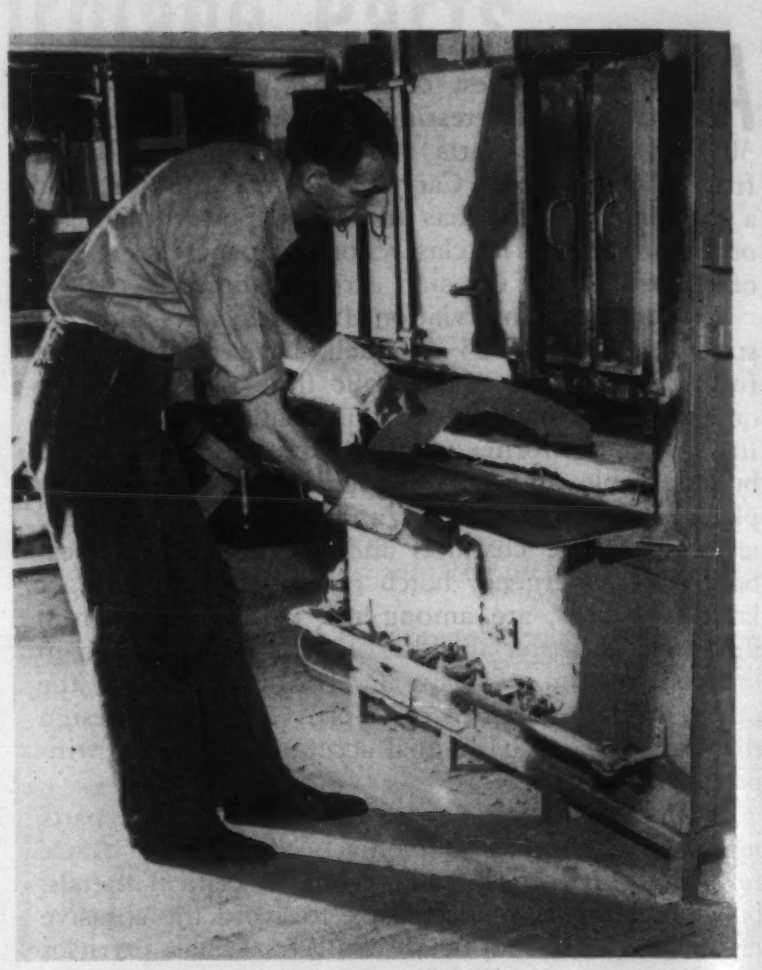
Properly to visualize the North American phenolic fibre forming method, we discuss here the forming of the gun ejector chute installed in the wing of the P-51 Mustang. This plane mounts machine guns in its wings, fired by remote control, the spent cartridge cases being ejected in a stream that falls into this chute which spills them into the air.

The idea for the phenolic fibre forming originates in engineering and a part drawing is conceived. An experimental mock-up is developed. The activity then becomes coordinated with tool planning and design. This is accomplished by a coordinator, who steers it through wood shop pattern making and into production. He is a most important factor in flat pattern development, and it is this liaison between engineering and production to which North American largely attributes its success. He follows tools and production, being responsible for correct material, formability and all other processing details. This coordination is of the utmost necessity as long as manufacturers remain unable to perfect a consistent plastic sheet.

From this activity, there is produced an engineering part drawing which tool planning uses to break down the sequence of operations and provide a routing or operations sheet. All this material and history is then passed to the die design group for necessary tool design drawing and tool orders.

Tooling

The tool design drawing is peculiarly individual, in that an artist's perspective is developed rather than a true mechanical drawing. The parts are of such nature that a mechanical drawing would be too involved. There is no bill of material. Dimensions are



An operator places an unformed part on the asbestos shelf of the preheat oven in the phenolic fibre department.

established by working from the engineering part drawing itself. All the different methods in press forming are involved, such as mounting in the press, quick acting clamps, stops, type of cam action, shrinkage allowances, stretch and cutout. All this requires good team work to develop a design that will accomplish the forming all at once and with a combination of manual and press operations. The wood shop, with all this material, proceeds to the die making. Masonite, maple, phenolic fibre and Kirksite are used.

Masonite is easily worked, rather cheap, and as fast as anything that can be used in such die making. Kirksite has unusual wearing ability, strength and impact resistance. It is easily machined, can be cut on a band saw, taps readily. Sheet Kirksite is used among other things for the hinge plates on the dies. It is easy to work and is remelted for other uses when the original die is obsolete. In larger dies, particularly where the spring back tendency has to be considered, maple is used to advantage.

The designer selects the die material, gets dimensions and layout from the engineering parts and tool design drawings and proceeds to that series of machining operations essential to making the die so that all forming will be accomplished in one press operation. Folding, cam movement, positioning, part holding, quick acting toggle clamps for the last forming operation, return flanges and pressure applied by pneumatic press are some of the die making considerations. Tool holes in back and sides are a par-

An operator removing a phenolic part from a die on a rotary turntable. He turns the table with a foot pedal, bringing the desired dies into position. Unformed parts are held between spindles in the center of the table.

ticular concern, in that all parts are worked from these which are coordinated with assembly jigs. They cannot be prelocated. Clamps usually are of the manually operated, quick action type.

The die maker develops a rough pattern template for blanking the part to prove the tooling is satisfactory at the same time the die is test run. All changes required are refined to make a completed and proved part. This is given a trial production flight. Dies demand unusually capable workmanship to achieve that polish and finish necessary to minimum friction. The flat blanking pattern is developed and shop contact checks it for symmetry and production work, based upon its coordination to the facilities of the North American three-plant setup at Kansas City, Dallas and Inglewood. It is then passed to master lines section, the part being still in the flat. Lofting prepares templates by fluorescent X-radiography and the blanking template is completely developed with all features, such as holes, notches, cut-outs and other information upon it. This is released to the shop to make any other necessary tools called out on the routing sheet, such as blanking and drill jigs.

Forming Methods

As a rule, the quantity of run, shape and size of the part determines whether the flat will be stamped by blanking die or contoured by router jig. These are also made by the tool department.

Before the regular production flow, it is necessary to "prepare shop." The male dies are set up and lubricated. A paraffin oil is used with wood dies while regular axle grease is used on Kirksite.

The pneumatic press of North American design, handling most of this phenolic fibre forming, is a multiple, three-cylinder press whose 12-in. cylinders have a 30-in. stroke, using 90 lb. line pressure, controlled by a manually operated valve. The three cylinders can operate individually or in unison. Designed specifically for this type of forming, pressure up to 11 tons is possible though the roof pressure on work to date is 5 tons. The press bed is 36 in. by 12 ft. The phenolic fibre on this ejector chute is a special Westinghouse No. 444 which has good flexibility and other favorable forming characteristics.

Floor layout facilitates handling. Preheat oven, press and flat storage facilities must be integrated for progression. The work is handled with leather gloves, blanks being first introduced into a gas-fired oven, the work being laid on asbestos shelves. The work will blister if it touches metal, though it is all right to suspend it by hooks through material holes. The oven size is determined by the blank forms to be accommodated.

Coming from the oven, the flats are placed on the press dies. A large monitor clock, graduated in seconds, is above the press. The time in the press varies between one and two minutes, being controlled by the judgment of the operator. Forming phenolics is a distinct art. The operator can tell the required press interval by the feel of the die and material. He usually checks the formability about 20 seconds before removing the formed part from the press. This check varies with thickness and other material characteristics.

The color of the phenolic fibre blank tells much concerning its curing. If dark, it is hard and probably overcured; if light, it is soft and undercured. The flexibility of the blank is a distinct forming consideration. The time of the forming cycle under pressure in the press for varied thicknesses approximates: 1/16 in., 60 sec.; 3/32 in., 90 sec.; 1/8 in., 120 sec.; 3/16 in., 150 sec.; 1/4 in., 3 min.

Assembly Operations

After forming, the tabs are trimmed and the part is drilled. Phenolic fibre is easily machined. The ejector chute is drilled in a jig to coordinate with the

An end plate is attached to the phenolic fibre gun ejector chute on the automatic squeeze riveting machine.

Using a hand drill, a mechanic countersinks holes in a phenolic part.

other parts involved in the assembly. The holes are countersunk for flush riveting. The ejector chute catches all cartridges, extracts them through the wing bottom, picks up no zinc or oxide, has greater wearing qualities than metal, and eliminates noise. There are six such chutes on each P-51 Mustang.

On all phenolic fibres, riveting is accomplished by pneumatic squeezers. Operating by air pressure, these squeezers save time and energy. The squeeze is in one operation and requires but one worker. It is important that a ⅜-in. edge distance be held from the center of the hole to the edge of the material. This gives sufficient clearance so that the phenolic form will not crack because of the riveting. The hole in phenolic forms has a tendency to spread with the swelling of the rivet rather than tightening, as is the case with metal.

By a vibrating type of riveting, the fibre has the tendency unduly to crack. Pneumatic slow squeezing prevents this. In flush riveting of phenolic forms, the countersink should be just slightly undersize as the rivet is self-seating. The riveting is to prevent any hazard to the feed into the ejector chute. Finally formed and riveted, the part is dipped in a solvent to prevent moisture and seal it against warp. It is then ready for assembly on the wing section of the P-51.

For other types of phenolic fibre forming, North American has invented a turn table rigging which accommodates ten dies for bench forming. This table is 8 ft. in diam., on rollers and the stops are positioned by foot pedal. Its center has a series of vertical classifying pegs to hold the flat blank stock for each die. The press loading zone is nearest the oven and the rotation is such that the operator loads, moves and extracts the varied forms from these bench dies in sequence. Clamped and held during the rotation, the cycle is timed to the interval of their proper removal after appropriate press time.

Post-War Use

Phenolic fibre is a material of which much use will be made in all forms of design after war. There is always some way to be found to form any part, no matter how complex in angle and contour. But the accomplishment depends upon the incorporation in the die of much shop experience. One must know how to handle the many variants in materials. Some of these will form, others will not. Greatest of all essentials is to know the art of forming phenolic fibres and to incorporate that knowledge into its die design, bearing in mind that the entire operation must occur in one stroke of the press.

The extensive use of phenolic fibre forming is shown by this collection of parts made in North America's own department.

METALS and ALLOYS
Engineering File Facts

NUMBER 82
June, 1945

Engineering Properties of Malleable Iron Castings

Malleable cast iron is a widely used engineering material that is a white iron in the as-cast condition. By a suitable heat treatment the hard and brittle white iron casting can be changed into a ductile, machinable material known as malleable cast iron (or, more simply, as malleable iron). Since malleable iron castings are generally poured in sand molds, they are subject to the same limitations and have the same advantages as other sand cast parts. Almost 50% of the metal poured goes into gates, risers, shrink-bobs and sprues.

The materials for malleable iron castings are usually melted and prepared in either a cupola, an air furnace, an open hearth, or in an electric furnace (or in combinations of these in duplex or triplex processes). Where high quality castings (having both high tensile strength and elongation) are desired, the air furnace or the open hearth (or a duplex or triplex process) is used. While the malleable iron made in a cupola is a higher carbon product and has lower tensile properties than air furnace iron, it is not necessarily of inferior grade. The cupola product usually has better machining qualities and produces pressure castings that are freer from leakage; this type of malleable iron is used largely for fittings, while the lower carbon air furnace iron goes into more railroad, motor vehicle and machinery parts.

There are four common types of malleable iron as listed in Table 1. The two important phases in the successful production of malleable iron castings are: Securing the proper analysis in the melt (a composition that will respond to the heat treatment) and using the correct malleablizing cycle. As in the case of gray cast iron, the chemical analysis of malleable iron is seldom incorporated in commercial engineering specifications. The approximate composition is included in Table I.

Some of the common engineering specifications for malleable cast iron are given in Table 2, with emphasis on the physical properties of the material rather than its chemical analysis.

The proper malleablizing heat treatments for malleable irons are very important in the production of uniform, machinable castings. Some representative malleablizing treatments are outlined in Table 3. It is to be noted that the effects of certain heat treatments are greatly influenced by the analysis of the iron being treated. Ladle additions of alloying agents are often used to control the structure and/or characteristics of the product. Some of these agents may aid or speed the graphitization process (Si, Al, Ti, Zr, Ni or Cu), others are used primarily

Table 2. Resumés of Common Engineering Specifications for Malleable Irons

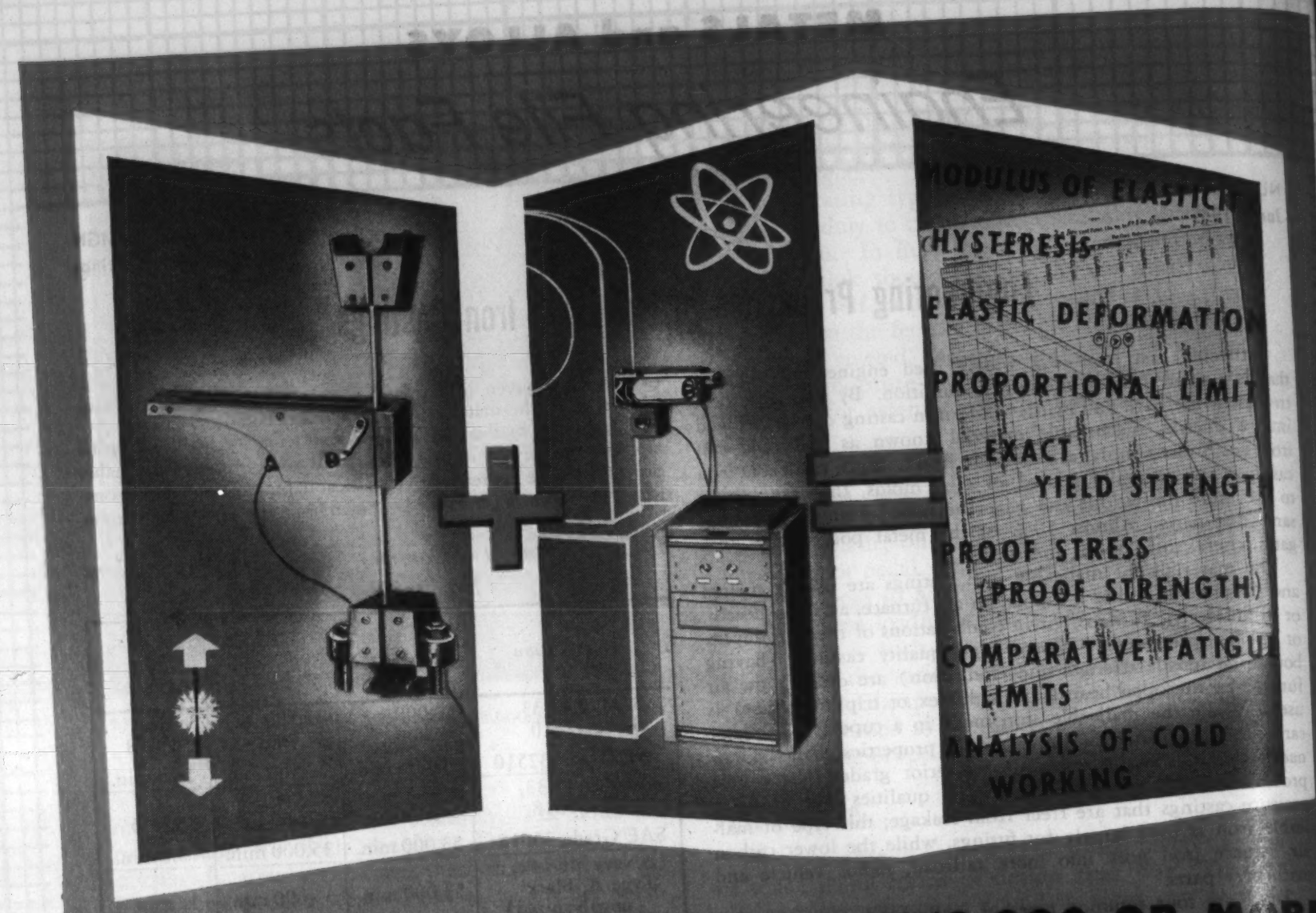
Specification	*Tensile Strength, p.s.i.*	*Yield Point, p.s.i.*	*Elong. in 2 in. %*
ASTM A47-33, Grade 32510	50,000-52,000	32,500-35,000	10-18
SAE Grade 32510	50,000 min.	32,500 min.	10.0 min.
ASTM A47-33, Grade 35018	53,000-60,000	35,000-40,000	18-25
SAE Grade 35018	53,000 min.	35,000 min.	18.0 min.
USNavy 46-I-8c, Type A, Black (ungalvanized)	53,000 min.	35,000 min.	18 min.
Type B, Zinc-coated (galvanized)	50,000 min.	32,500 min.	10 min.
Federal QQ-I-666	Same as 46-I-8c		

Table 1. Types of Malleable Cast Iron

Type	*Approximate Composition, %*	*Approximate Heat Treatment*[1]	*Structure After Malleablizing Heat Treatment*	*Remarks*
Malleable Iron	Total carbon: 1.75-3.00 Silicon: 0.75-1.00	Soak at 1500-1800 F. until massive cementite is decomposed, then cool slowly (10°-30° per hr.)	Small nodules of "temper carbon" or graphite imbedded in a matrix of ferrite	A cheap, tough, machinable material used where resistance to shock and wear is needed; annealing costs $5.00-6.00 per ton and requires 3-7 days in typical batch type furnaces
Pearlitic Malleable Iron	Total carbon: 2.00-3.00 Combined Carbon: 0.30-0.40 Silicon: 1.00-1.20	Interrupt the malleablizing treatment before completion and cool the castings 10-100 F. per hr.; or cool rapidly after malleablizing, then reheat to form pearlite	Has some combined carbon (in pearlite) in ferritic matrix; graphite is also present	Has higher strength and yield point and lower elongation than ordinary malleable iron; compared with forgings and wrought steels of the same hardness, it may be machined in less time and with longer tool life
Spheroidized Malleable Iron	(Same as for pearlitic malleable)	The partial graphitizing heat treatment (see above) is followed by a spheroidizing treatment at 1200-1300 F.	Has spheroidized cementite (combined carbon) in a matrix of ferrite	This material has higher ductility than pearlitic malleable iron and may be malleablized and spheroidized in a fairly short cycle
Alloy Malleable Iron	Similar to regular malleable with the addition of small amounts of ferrite strengthening alloys (such as Al, Cu or Ni)[2].	May be any one of the above three types or heat treatments, depending upon analysis and upon the structure desired	May be any one of the above three types of structure	Intermediate in strength between ordinary malleable iron and low carbon cast steel; a bit more expensive than ordinary malleable iron; has good machining qualities and high yield point; not as common as above types

[1] The actual heat treatment will vary with the analysis of the iron, with the type and size of charge, as well as with the type of annealing furnace used.
[2] An example would be the Ford crankshaft of the following composition: 1.50 C, 1 Si and 1.75% Cu, although this is often called a cast steel.

(Continued on page 1669)



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2. Any Universal Testing Machine equipped with an Olsen Electronic High Magnification Recorder — in the same time required to make a non-recorded test — gives the following additional essential information:

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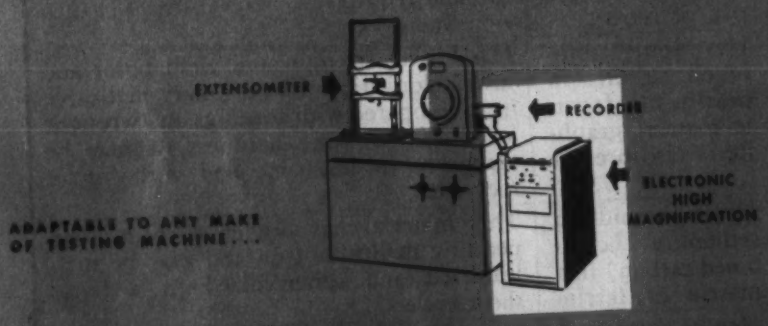
2 — Hysteresis
3 — Elastic Deformation
4 — Proportional Limit
5 — Exact Yield Strength
6 — Proof Stress (Proof Strength)
7 — Comparative Fatigue Limits
8 — Analysis of Cold Working



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to strengthen the ferrite, some will retard the decomposition of pearlite, and the formation of graphite is retarded by such elements as Mn, Cr, Mo, V, and W.

A short preheating (600 F. for 8 hr.) is sometimes used for promoting graphitization; this treatment evidently increases the number of crystallization centers at which graphite modules can form. Also, the silicon content influences the time required for graphitization; irons containing 1% Si require about 24 hr. at 1700 F. for complete graphitization while 1.7% Si irons can be graphitized in approximately 3 hr. at the same temperature. From these facts, it can be seen that silicon promotes graphitization and, therefore, is kept as high as possible consistent with good physical properties.

In addition to the malleablizing heat treatments mentioned above, malleable iron castings may be heat treated for increased hardness or surface hardened (by salt bath, or by flame or induction hardening). Some types of malleable irons may be hardened to 350-500 BHN, depending upon the treatment and tempering temperature. Surface hardened castings may be 400-500 BHN after treatment.

Table 3. Representative Malleablizing Heat Treatments

Type of Malleable Iron	*Steps in the Heat Treatment Process*
Cupola Malleable Iron	1. Heat castings to 1650-1750° for 40-60 hr.[3] 2. Cool slowly (at not more than 10° per hr.) to 1250° 3. Remove castings from the furnace and air cool
Spheroidized Malleable Iron	1. Heat castings to 1650° for 15 hr.[4] 2. Cool in furnace (with door open) to 1250° 3. Hold at 1250° for 20 hr. 4. Remove castings from furnace and air cool (Total time = 48 hr.)
Alloy Malleable Iron (The Ford Crankshaft)[5, 6]	1. Heat castings to 1650° for 20 min. 2. Air cool to 1200° 3. Reheat to 1400° and hold for 1 hr. 4. Furnace cool in 1 hr. to 1000° 5. Remove castings from furnace and air cool

[3] Using a box furnace with the castings sealed in boxes, the time for step 1 varies from 40 to 60 hr.; in a continuous controlled atmosphere furnace this part of the process can be performed in 18 to 36 hr.

[4] From "Short Cycle Malleablizing of White Cast Iron," Howe, Iron Age, Vol. 155, Jan. 18, 1945, pp. 66-68.

[5] See also Table 1 and Table 4.

[6] From "Metals and Alloys Data Book," (Reinhold Publishing Corp.) p. 212.

Table 5. Common Trade Names of Special Malleable Irons

Trade Name	*Type of Malleable Iron*	*Remarks*
Promal	Pearlitic malleable iron	A Link-Belt Co. product and one of the early pearlitic malleables on the market
Z Metal	Several types of pearlitic and spheroidized malleable irons with low alloy contents	Made under Ferrous Metals Company's patents; a range of strength and hardness (as cast) are available
Super-Y	An alloy malleable iron	This material is intermediate between ordinary malleable and cast steel; its tensile strength is 62,000 p.s.i.; yield point is 45,000 p.s.i.; and has an elongation in 2 in. of 18-20%
Supermal	Specially processed hard malleable	Produced by Jefferson Mfg. Co.
Belmalloy	An electric melted pearlitic malleable	A type by Belle City Malleable Co.
Flecto Iron	Specially annealed to prevent brittleness when hot galvanized	Product of Ohio Brass Co.
Lancast Alloys	A series of high strength, abrasion resistant malleables	Lancaster Malleables and Steel Corp. is the producer
Armasteel	High strength pearlitic malleable iron	Made by Saginaw Malleable Iron Co.
Certified Malleable Iron	A high strength malleable	Produced by Erie Malleable Iron Co.

Table 4. A Comparison of the Physical Properties of Malleable Iron and Other Cast Ferrous Materials

Material	*Tensile Strength, p.s.i.*	*Yield Point, p.s.i.*	*Elong. in 2 In.*	*BHN*	*Solidification Range, Deg. F.*	*Shrinkage Per Ft.*	*Weight Lb./Cubic In.*	*Machinability*	*Mod. of Elasticity*
Gray iron[8]	28,000-34,000	—	—	165-200	2000-2400	1/8 in.	0.252-0.271	—	14,500,000
Ordinary Malleable Iron[9]	50,000-60,000	30,000-40,000	10-25%	110-140	2065-2100	3/16-1/4 in.	0.259-0.268	100-150	25,000,000
Pearlitic Malleable Iron	60,000-80,000	35,000-45,000	8-15%	140-200	—	3/16-1/4 in.	0.259-0.268	70	27,000,000
Alloy Gray Iron[10]	60,000	—	—	275	—	—	—	—	20,000,000
High Strength Cast Iron[11]	50,000	—	—	350	2120-2325	4/32-5/32 in	—	48	21,000,000
0.30% C Cast Steel (Annealed)	70,000-80,000	40,000-50,000	25%	140-155	2590-2695	1/8-1/4 in.	0.284	—	30,000,000
Alloy Malleable Iron[6, 7]	120,000	95,000	65%	255	—	—	—	—	27,000,000

[7] See Footnote (5) Table 3; [8] ASTM Type 30; [9] ASTM Grades 32510 and 35018 (averages); [10] ASTM Type 60; [11] Meehanite GA.

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METALS and ALLOYS
Engineering File Facts

NUMBER 83
June, 1945

METHODS AND PROCESSES
Forging

Forging Magnesium Alloys

When very light parts are required for a structure, with stiffness and strength as corollary requisites, magnesium forgings may be considered as a possibility. The lightest structural metal, magnesium alloy, in the forged condition possesses tensile strengths of 45,000 to 53,000 p.s.i., while cast alloys usually develop about 35,000 to 40,000 p.s.i. It weighs only about two-thirds as much as aluminum alloys, and less than one-fourth as much as steel. Its strength is low in comparison with steel, with modulus of elasticity of 6,500,000 p.s.i., but because of the added amount of material available by reason of its low weight, stiffness of light parts may frequently be increased by making them of magnesium.

Weights of magnesium forging alloys compared to those of other common metals are:

Metal	Mg	Al	Gray Cast Iron	Cold Rolled Steel	Brass	Monel
Weight—lb./cu. in.	0.065-0.067	0.096	0.256	0.283	0.309	0.321

Magnesium may be forged by hammer, press, or upset methods. The alloy must be selected with regard to the type of forging process and to physical properties required. Standard alloys used for forging are given in the following table:

Table 1. Magnesium Forging Alloys

Designation			*Nominal Chemical Composition*								*Remarks*
Am. Mag.	*Dow*	*ASTM*	*Al*	*Zn*	*Sn*	*Si (max.)*	*Mn (min.)*	*Ten. Str.*	*Yld. Str.*	*Elong.*	
AM3S	M-1	11	—	—	—	0.3	1.2	36,000	26,000	7	Lowest cost alloy. Easily forged, and easiest to weld.
AM52S	FS-1	18X	2.5-3.5	1.3 (max.)	—	0.3	0.1	39,000	28,000	15	Easily forged, with widest temperature range.
AM57S	J-1	8X	5.8-7.2	0.4-1.5	—	0.3	0.15	42,000	27,000	12	General purpose alloy. Good strength but somewhat difficult to forge.
AM58S Aged Quenched and Aged	O-1	9X	7.8-9.2	0.8 (max.)	—	0.3	0.15	46,000 48,000 50,000	32,000 34,000 34,000	10 6 6	Heat treatable; good strength. Most difficult to forge.
AM65S	D-1	—	3.0-4.0	—	4.0-6.0	0.3	0.4	38,000	22,000	12	Easily forged on presses or hammers.

Addition of the letter "S" to the alloy designation indicates a high-purity grade of the same nominal composition.

In addition to these alloys, the composition AM-C74S is sometimes used for press forgings. It has a somewhat higher elongation than the other forging alloys. The composition is 3.0 Al, 3.0 Zn, 0.2% Mn, balance Mg.

Alloys containing more than 6% Al are difficult to forge rapidly, so that AM3, AM52, and AM65 are usually used for hammer forgings. When the higher strengths of AM57 or AM58 are required, the part is usually fabricated on hydraulic or mechanical presses, or by a combination of operations with hammers and forging presses. Use of hammers may reduce the size of required forging equipment.

As magnesium alloys of less than 8.0% Al content do not respond readily to heat treatment or aging, it is necessary to rely upon stock, blocker die design, rate of working, and temperature of forging for physical properties of AM3, AM52, AM57, AM65, and when used, AM-C74. AM58 may be supplied in the heat treated condition. A solution treatment of 2 hr. at 700 F., a water quench, and an aging treatment at about 340 F. for 20 hr. is typical. This treatment is designated as T5, and results in increasing the yield strength, with slight decrease in elongation.

Forging stock is usually extruded rod or other extruded material, providing a fine grained, sound stock. It is usually cut to size on an abrasive wheel cut-off machine. Great care must be taken that the cut be smooth, and that all notches, sharp corners, tool marks, and other stress-raisers be eliminated.

The design should make provision for generous fillets and radii, and section changes should be as gradual as possible. For most forgings, dies designed for aluminum are suitable for magnesium also. Tolerances for size and mis-match are in general the same. These might be: For dimensions under 2 in., ±0.010 in. increasing by ±0.003 in. for each additional in.; for height, through parting line, ±1/32 in. for small forgings, ±1/16 in. for large forgings.

Draft allowance for hammer forgings is usually 7°, as for aluminum, with smaller allowance for press and upsetter dies. Die life is about the same as for aluminum. A good quality die steel should be used.

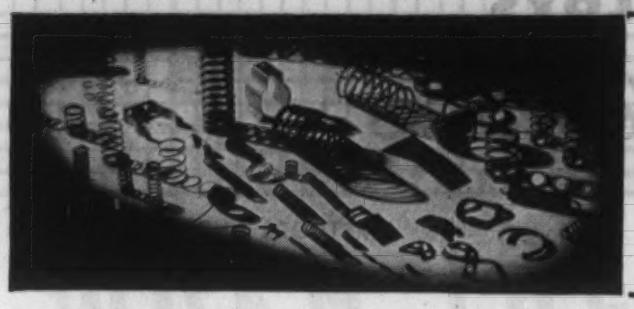
Forging temperature ranges in use for the standard alloys are: AM52S, 600 to 800 F.; AM57S, 600 to 700 F.; AM58S, 600 to 700 F.; AM65S, 700 to 800 F.; AM74S, 600 to 650 F.

In production, the job is set up to run at a definite temperature, ±10 F. Whenever possible, the entire forging operation should be done in one heat, as reheating increases the possibility of cracking transversely to original flow lines of the material. Trimming should be done at a temperature of about 400 F.

Lubricants in common use are tallow, beeswax, colloidal graphite in water, combinations of oil and graphite. These are usually applied to the dies by spraying.

The forgings are usually given a chrome-pickle treatment to protect them during storage or shipment.

Prepared by Kenneth Rose, Engineering Editor



The I-S SPRINGBOARD

VOL. 2 NO. 4

Published by INSTRUMENT SPECIALTIES CO., INC.

224 BERGEN BOULEVARD — LITTLE FALLS, NEW JERSEY

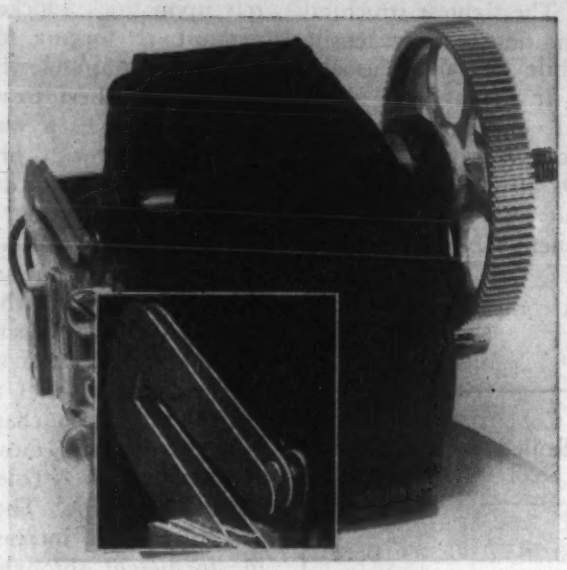
FILEWORTHY FACTS ABOUT MICRO-PROCESSED BERYLLIUM COPPER

PRE-FORMED SPRINGS SPEED ASSEMBLY OF FIELD TELEPHONE GENERATOR

Holtzer-Cabot Eliminates Costly Hand Adjustments By Using Accurately Pre-Formed Be Cu^{mp} Springs

Ability of Beryllium Copper^{mp} to be pre-formed during hardening has made it possible for Holtzer-Cabot to produce contact assemblies for their field telephone generators without any manual adjustment — resulting in lower production costs, faster assembly, and less drift in service.

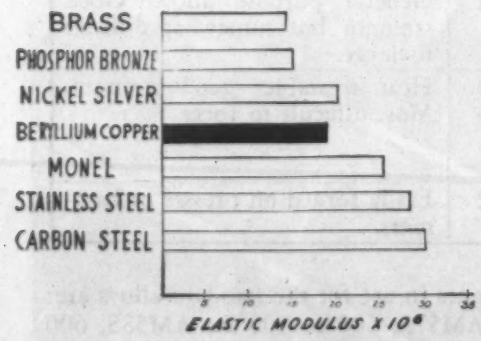
The contact assembly, consisting of two identical blades with slight offset, must maintain contact pressure within relatively narrow limits. The traditional answer to this problem was to assemble the blades flat and bend each blade by hand, overbending to allow for springback and inevitable relaxation. This method is obviously costly and open to human error; there is lack of permanence in the adjustment, especially for high temperature service conditions. In addition, the ductility needed for bending requires a substantial sacrifice of obtainable spring properties in beryllium copper.



Holtzer-Cabot supplied Instrument Specialties with carefully adjusted model assemblies to give exact pressure required. I-S engineers then developed tools to produce the required offset angles and heat-treating fixtures to hold the angles during hardening heat-treatment. No adjusting is necessary when assembling the micro-processed contact blades.

Design engineers are invited to discuss such cost saving and design improving plans with I-S engineering staff.

ELASTIC MODULUS of BERYLLIUM COPPER^{mp} COMPARED WITH COMMON SPRING ALLOYS



One physical constant which always enters into the design of springs is the elastic modulus or the ratio of load to deflection for a given design. This stiffness characteristic of spring materials influences the selection of the material for many applications. If a large amount of energy is to be stored within a small space, a stiff material having a high modulus (low deflection) is used. If sensitivity is needed, as in instrument springs, a low modulus material is selected which has a large deflection with a given load.

Modulus also affects working stresses. For a spring with a given deflection, the material having the highest modulus will be the highest stressed. Since beryllium copper has a modulus value midway between nonferrous spring materials and steel, it can be designed either for sensitive calibrated springs or for energy storing springs.

The modulus of heat-treated Be Cu is considerably higher than that of the un-hardened alloy. If deflection rate is important, developmental or experimental parts should be made only from properly hardened Be Cu^{mp}.

I-S laboratory facilities are available for consultation on any modulus question.

FROM THE I-S LABORATORY

TEMPERATURE COMPENSATION OF SPRINGS

In an adjoining table are elastic modulus values for commonly used spring alloys at room temperature. All of these alloys, including Beryllium Copper, show a change in modulus or stiffness with a change in temperature, most materials showing increased deflection at a given load with an increase in temperature. Increase in deflection of beryllium copper springs is approximately one percent for each 30° C. rise in temperature.

In calibrated springs where the effects of temperature are important, temperature errors are usually compensated by such means as bi-metallic elements, change in resistance, or change in permeability with temperature. Compensation may also be obtained by using a spring made up of two elements*; one, usually beryllium copper, having the normal negative temperature coefficient and the other element of invar which has the unusual property of increasing stiffness with temperature rise.

Elinvar, a nickel-chromium-iron alloy has no change in modulus with temperature but must be used in the annealed state, restricting it to low stress applications. A similar alloy, Iso-Elastic, has a constant modulus when severely cold worked and heat-treated, which allows higher working stresses and a wider field of use.

Recently, a new age hardening alloy of the Elinvar type has been developed which combines some of the desirable properties of beryllium copper with a constant modulus. This alloy is still in the experimental stage but shows considerable promise. We would be glad to keep you posted if you are interested.

* Patent No. 2,236,158

LITERATURE

A limited number of copies of an article by F. S. Stickney, "Making Spring Grade Beryllium Copper Wire," are available through the courtesy of Little Falls Alloys, Inc. I-S will gladly send you a copy upon request.

ENGINEERING SHORT-CUTS

An increasing number of design and production engineers have been stating their spring specifications on **performance** rather than design. Actually, these engineers tell us what they want a particular spring to do, and then ask us to produce a spring to meet their physical and service requirements. The I-S engineering staff will gladly accept design responsibility and will produce springs to meet such performance specifications. To accept this responsibility we need to have the following information:

(1) How the spring is to be used.
(2) The frequency with which it operates.
(3) Maximum operating temperature.
(4) Corrosive conditions to be met.
(5) What tolerances are critical.
(6) The degree of stability required.

These are important as well as the following standard details as:

(1) Working load and working length.
(2) Maximum solid height and solid length.
(3) Maximum outside and inside diameters.

The short cut to maximum spring performance is to give the above data to I-S. We'll do the rest.

METALS and ALLOYS
Engineering File Facts

NUMBER 84
June, 1945

MATERIALS AND DESIGN
Glass

Glass—Types and Compositions

Glasses are defined by the A.S.T.M. as inorganic products of fusion that have cooled to a rigid condition without crystallizing. They are classified as: (1) One-component glasses, including fused silica, boric oxide, and phosphoric oxide; (2) Two-component glasses, chiefly the soluble silicates; and (3) Multi-component glasses, including (a) the soda-lime-silica types, the material for the great bulk of commercial glassware; (b) borosilicate glasses, ranging from soda-lime-silica glasses with small amounts of added boric oxide to low-expansion glasses containing little or no lime or soda; (c) special glasses, including (1) flint glasses, containing lead oxide, and ranging from cut glass to heavy lead glasses; (2) optical glasses, usually silicate or borosilicate types; and (3) non-silicate glasses, of limited use for special purposes.

Of glass in general, one of its most valuable properties is that of extreme chemical stability, being second only to the noble metals in this respect. It resists attack by all acids except hydrofluoric, but is attacked by strong alkalies. Another is its transparency, when desired. Its electrical insulating properties and non-combustibility are also responsible for large-scale uses. Other properties of value are its practically unlimited color possibilities, excellent weathering qualities, extremely low coefficient of expansion, and its hardness.

Glass can be molded or blown to complex shapes, but is practically non-machinable and cannot be cold formed. It can be cut or drilled, and may be shaped when heated to plasticity. Glasses other than the one-component type have no melting point, but the softening temperature is given as the point at which the viscosity is so reduced by heat that it reaches some arbitrarily set degree of mobility.

Tensile strength tests have little meaning, as the results are not reproducible from specimen to specimen. The condition of the surface, nature and amount of internal stress, and size of the specimen greatly affect results. For example, an annealed test bar about ¼ in. in diam. might be expected to carry about 10,000 p.s.i., but fine fibers may show results as high as 500,000 p.s.i. Tensile strength may be determined as modulus of rupture, however.

Coefficient of expansion is the property of greatest importance in estimating thermal endurance. In general, silica and boron oxide lower the coefficient, the alkalies raise it the greatest amount, and other oxides have an intermediate effect.

Abradability, or yielding to grinding, is a practical measure of ease of polishing. Taking fused quartz as 1.0, pyrex glass would have a value of 1.7, and so on down to 5.0 for the soft lead glasses.

Modulus of elasticity for soda-lime glasses may be between 8.2 by 10^6 and 1.2 by 10^7 p.s.i. Values of the modulus are increased by progressive substitution of lime for soda in the glass. Lime and magnesia in general increase the modulus, and boron oxide also causes an increase when present in amounts to 15%. Larger percentages cause a decrease.

These basic properties are capable of wide variation when glass is prepared for a specific purpose. Glass is available in a great variety of forms, and in combination with other materials to give it great versatility.

Glass Varieties

Name	General Description		Characteristics
Fused Silica	Pure SiO_2		Lowest expansion, best light transmission, greatest chemical durability
Phosphate	High P_2O_5		Resistance to hydrofluoric acid
High Silica	About 96% SiO_2		Approaches fused silica in thermal shock resistance
Heat-Resisting	Borosilicate		Low expansion, great durability
Thermometer	Borosilicate		Small "afterworking"
Plate	Soda-lime		Good durability
Window	Soda-lime		Good durability and workability
Container	Soda-lime-magnesia-alumina		Good workability
Bulb	Soda-lime-magnesia		Extreme workability
Tubing	Soda-lime-magnesia-alumina		Workability, controlled expansion
Tableware	(a) soda-lime-magnesia-alumina		Color, workability, durability
	(b) potash-lead		Color, luster, tone
Optical	(a) optical flint	many compositions	Fixed optical properties, high homogeneity
	(b) optical crown		
	(c) spectacle		

Typical Compositions

	Pyrex Type	Thermometer	Plate	Window	Bottle or Container	Bulb	Tubing	Lime Tableware	Lead Tableware	Optical, Flint	Optical, Crown	Spectacle
SiO_2	81.0	72.9	72.7	72.0	74.0	73.6	72.1	74.0	67.0	49.8	69.6	73.0
Al_2O_3	2.0	6.2	0.5	0.6	1.0	1.0	1.6	0.5	0.4	0.1	—	—
B_2O_3	12.0	10.4	—	—	—	—	—	—	—	—	9.9	—
SO_3	—	—	0.5	0.7	tr.	—	—	—	—	—	—	—
CaO	—	0.4	13.0	10.0	5.4	5.2	5.6	7.5	—	—	—	12.0
MgO	—	0.2	—	2.5	3.7	3.6	3.4	—	—	—	—	—
BaO	—	—	—	—	tr.	—	—	—	—	13.4	2.5	—
PbO	—	—	—	—	—	—	—	—	17.0	18.7	—	—
Na_2O	4.5	9.8	13.2	14.2	15.3	16.0	16.3	18.0	6.0	1.2	8.4	14.0
K_2O	—	0.1	—	—	0.6	0.6	1.0	—	9.8	8.2	8.4	1.0
ZnO	—	—	—	—	—	—	—	—	—	8.0	—	—
As_2O_5	—	tr.	tr.	tr.	tr.	tr.	—	tr.	tr.	0.5	0.3	tr.

Prepared by Kenneth Rose, Engineering Editor

COMPLETED 1942

Arcos and AUSTENITIC ARMOR WELDING

COMPLETED 1944

Arcos and FERRITIC ARMOR WELDING

COMPLETED 1945

Arcos and JET PROPULSION WELDING

Under a secrecy order, Arcos has been working for over two years on an electrode to weld the new metals developed for jet propulsion planes. The electrode must produce a weld metal that will withstand the great temperatures and stresses encountered in the engines of these speed demons of the air.

Arcos may not disclose publicly the chemistry or the physical properties of this new weld metal. It can and hereby does advise those involved in the manufacture of jet propulsion engines, that it is prepared to give them the proper electrode.

Arcos didn't seek this problem—the problem sought Arcos. It is only one of several tough ones solved by Arcos, and we are always prepared to take on new ones. That's the way Arcos makes friends.

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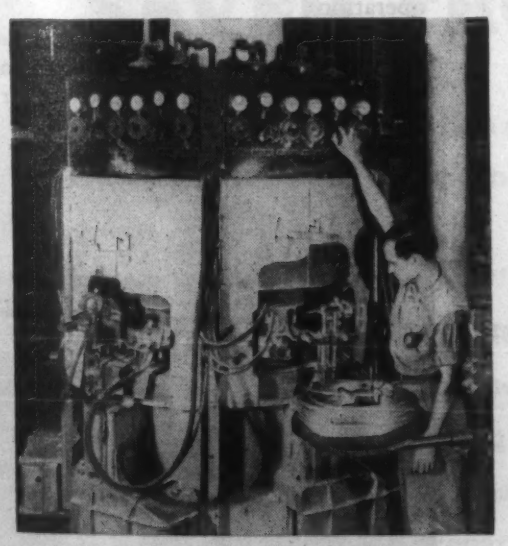
Fresno, Calif.....Victor Equipment Co.
Ft. Wayne, Ind..Wayne Welding Sup. Co., Inc.
Honolulu, Hawaii..Hawaiian Gas Products, Ltd.
Houston, Texas...Champion Rivet Co. of Texas
Kansas City, Mo..Welders Supply & Repair Co.
Kingsport, Tenn.....Slip-Not Belting Corp.
Los Angeles, Calif.....Victor Equipment Co.
Milwaukee, Wis.....Machinery & Welder Corp.
Moline, Ill.....Machinery & Welder Corp.
Montreal, Canada..G.D.Peters & Co. of Canada, Ltd.
New Orleans 13, La...Gulf Welding Equip. Co.
New York, N. Y.....H. Boker & Co., Inc.
Oklahoma City, Okla..Hart Industrial Supply Co.
Pampa, Texas.....Hart Industrial Supply Co.
Pittsburgh, Pa.....Williams & Co., Inc.
Portland, Ore.....J. E. Haseltine & Co.
Rochester, N. Y.....Welding Supply Co.
San Diego, Calif.....Victor Equipment Co.
San Francisco, Calif.....Victor Equipment Co.
Seattle, Wash.....J. E. Haseltine & Co.
Spokane, Wash.....J. E. Haseltine & Co.
St. Louis, Mo.....Machinery & Welder Corp.
Syracuse, N. Y.....Welding Supply Co.
Tulsa, Oklahoma.....Hart Industrial Co.
Wichita, Kansas.....Watkins, Inc.

engineering SHOP NOTES

Spraying Aluminum on Aircraft Engines

by E. M. Littel,
Chevrolet Motor Div., General Motors Corp.

A modern metallizing process sprays a coating of aluminum, 0.002 to 0.004 in. thick, on the cylinder head and barrel assembly of Chevrolet-built Pratt & Whitney aviation engines installed in bombers, troop or cargo transport planes to prevent corrosion due to extremes of weather. Aluminum, in the form of wire, is vaporized into a spray as it is fed through a special gun by a combination of air pressure, natural gas and oxygen.



First, surfaces of the assemblies are thoroughly cleaned and slightly roughened. Cleansing or degreasing is by immersion in a solvent vapor. The roughening is by sandblasting with fine sand. The metallizing machine, 6 ft. in diam., has a rotating table equipped with six fixtures. The assembly rotates slowly while the metallizing gun travels vertically. Scavenger oil lines are hand sprayed.

No. 11 gage aluminum wire is fed through guns at 4¼ to 4¾ ft. per min. Oxygen is supplied from a battery of cylinders, with pressure regulated to 28 to 33 p.s.i. Air, with all moisture removed, is fed in at 60 to 65 p.s.i. Compressed natural gas is available at 26 to 30 p.s.i. A completed assembly is turned out every 40 sec.

Protecting Bearings With Air Conditioning

by A. W. Martinez,
J. M. Mathes, Inc.

Perhaps no manufactured product needs more high precision accuracy in its manufacture than anti-friction bearings. SKF Industries have much improved their record for accuracy through air conditioning equipment with a capacity of 24,000,000 cooling units or 2,000 tons of refrigeration.

The smallest of several thousand different bearings made at SKF are ground to a surface finish accurate to one millionth of an inch. Even perspiration on the hand will attack the surface of a bearing and eat into its finish. To guard against this before air conditioning was installed, SKF bearings carried a heavier coating of oil for protection during handling. However, dust, grinding grit and particles in factory air collected more easily on the heavier oiled surface, threatening destructive abrasions in service, often at 50,000 r.p.m. Moreover, the dust made size gradings complicated.

In the new windowless blackout plant near Philadelphia, the entire manufacturing, assembly and inspection areas are kept at a constant temperature of 80 deg. and humidity of 45%. Electrostatic air cleaners in the critical assembly and inspection operations filter out nearly 100% of all smoke, haze and dust. To maintain air control, 4,000 gal. of chilled water are poured into air washers at 43 F. and leave at 55 F.

Air conditioning at SKF performs four essential jobs: Helps prevent stain-producing humidity from attacking finely finished bearing parts or assembled bearings; helps maintain accurate dimensional controls, not affected by varying outdoor climate; keeps factory atmosphere free from lint, dust, dirt, vapor and grinding grit; prevents excessive summer temperature from increasing workers' fatigue.

Before controlled indoor weather was installed, summer temperatures rose as high as 94 F., making painstaking inspection and assembly work for women almost intolerable. Excessive moisture on the hands of operators has been eliminated and the oil film on bearings has been reduced to a point where it is barely visible to the naked eye.

Correcting Defective Cartridge Cases

by Fred Masotta,
Winchester Repeating Arms Co.

There are two chief defects that materialize in the manufacture of caliber 30 military brass cartridge cases for Garand and Springfield rifles: Dimensions are too long overall, or the mouths have become bent or flared. At the point where the imperfect cases are detected, they have undergone 40 operations and four inspections. Previously, these defects were thrown into the scrap pile and remelted.

At the Winchester Repeating Arms Co., division of Olin Industries, we devised two machines that quickly restored perfect condition in the cases and that have rescued to date 11,000,000 cases, thus saving 440,000,000 operations and 44,000,000 inspections. These cases are ready to have primers inserted, or already have been primed and are about to be loaded with powder and bullets.

Conventional trimming machines could not be used to correct over-length since the machines are designed to work on them before annealing, but with these cases annealing has been performed with resultant softening of the brass. Thus, the direct piercing cut of such machines would distort the cartridge case. After correction by the new methods the cases are returned to that point in the production line that they left.

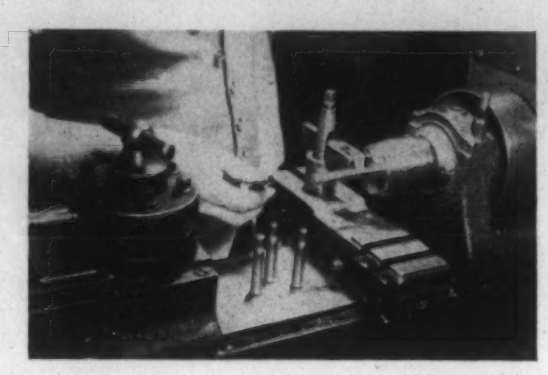
We selected a cutting tool of "Motung" No. 1 high-speed steel, with an outside cutting radius of 2⅛ in. and an inside radius of 1¾ in. The tool's cutting clearances are: Top, 10 deg.; backside, 5 deg. and point end, 3 deg. The tool has an overall length of 4½ in., is ⅝ in. wide, with a thickness of $^{5}/_{16}$ in.

The tool is mounted on a cross feed slide of a Pratt & Whitney No. 1 turret lathe, and is manually operated. A spring bushing is placed in the head of the machine to hold a specially-designed sleeve into which the cartridge case has been inserted. The sleeve, made of spring steel, is 1½ in. long with an outside diam. of

⅝ in. The inside of the sleeve is tapered to the same angle as the case.

The case is inserted into the sleeve, and both then inserted into the machine head. The curved cutting tool is fed against the revolving case, "shaving" it to correct length without distorting the end or causing any burrs. About 800 cases an hr. can be corrected.

To correct bent or flared mouths, we designed a special arbor and a roller mounted in a holder. The arbor, of spring steel, has an overall length of 4⅝ in., a diam. of ¼ in., and has a 2-in. shank and a ¼-in. tapered point. The arbor is fitted into the head of a Pratt & Whitney No. 1 turret lathe.



The roller, of tool steel, is 1¼ in. in diam. and ½ in. wide, mounted in a holder 4½ in. long, 1 in. wide and ½ in. thick. The roller assembly is set into a tool holder mounted on the cross feed slide of the lathe. The case is slipped onto the revolving arbor, and the roller, manually operated, is pressed against it, working it back to its correct shape. An operator can correct approximately 800 units an hr.

Photo 1 shows the cases being shortened; Photo 2, the bent and distorted mouths being corrected.

[The author has twice been awarded the War Production Board certificate for production ideas, and has been financially rewarded by Winchester—Editor.]

Silicosis is a chronic disease of the lungs due to the continued inhalation of fine dust containing silicon dioxide. It develops very slowly, requiring 3 to 20 yr. or more to produce sufficient pathology to cause disability. Recently it has been found that the breathing of finely divided metallic aluminum forms a peculiar chemical reaction with silica dust, affording relief to many silicosis patients. It is claimed to have a definite value as a preventive measure. The treatment is still experimental, but promising.

—The Illuminator, Dec. 22, 1944.

Diffused Light for Tool Inspection

by E. T. Larson,
Norton Co.

The following device speeds up the grinding of single point tools. Features are frosted glass for creating diffused light from an ordinary 100-watt electric light bulb. The grinder inspects the tool and template in front of the illuminated background, thus providing unusually good visibility.

The device consists of a fabricated lighting fixture mounted at approximately eye level on the top of each carbide tool grinder to facilitate checking the contour of the tool. Without leaving his machine, the operator can quickly observe the accuracy of his grind by simply raising the tool and template in front of the illuminated background.

The lighting fixture is made from scrap ⅛-in. boiler plate. The top and bottom panels, each 6 by 9 in., and two end panels, 6 by 6 in., are welded into a box-like structure. Along each of the four lengthwise edges pieces of ½-in. angle iron are welded to the top and bottom panels, projecting from either side $^{3}/_{16}$ in., or sufficient to allow a ⅛-in. thick frosted glass panel to slide freely through the opening.

A hole, large enough to receive an ordinary lamp socket, is drilled through one of the end panels. The bracket for the fixture consists of two steel straps bent and screwed to the top of the grinding machine.

(From "Grits and Grinds")

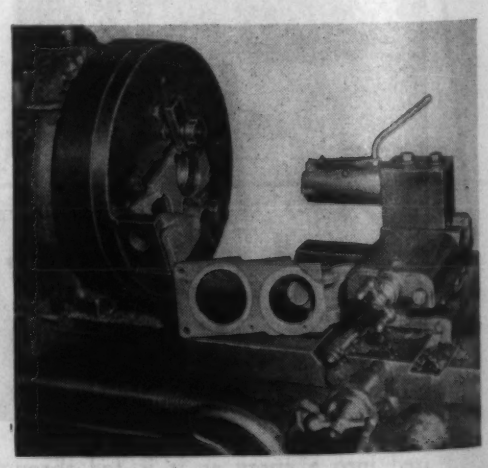
Chamfering Tool That Eliminates Scrap

by V. G. Lawson,
Westinghouse, East Springfield, Mass.

When boring the bracket shown in the accompanying photograph, many pieces were scrapped because new and inexperienced operators had difficulty resetting the boring cut after the cross slide was moved from set position to chamfer the hole at the back of the bore.

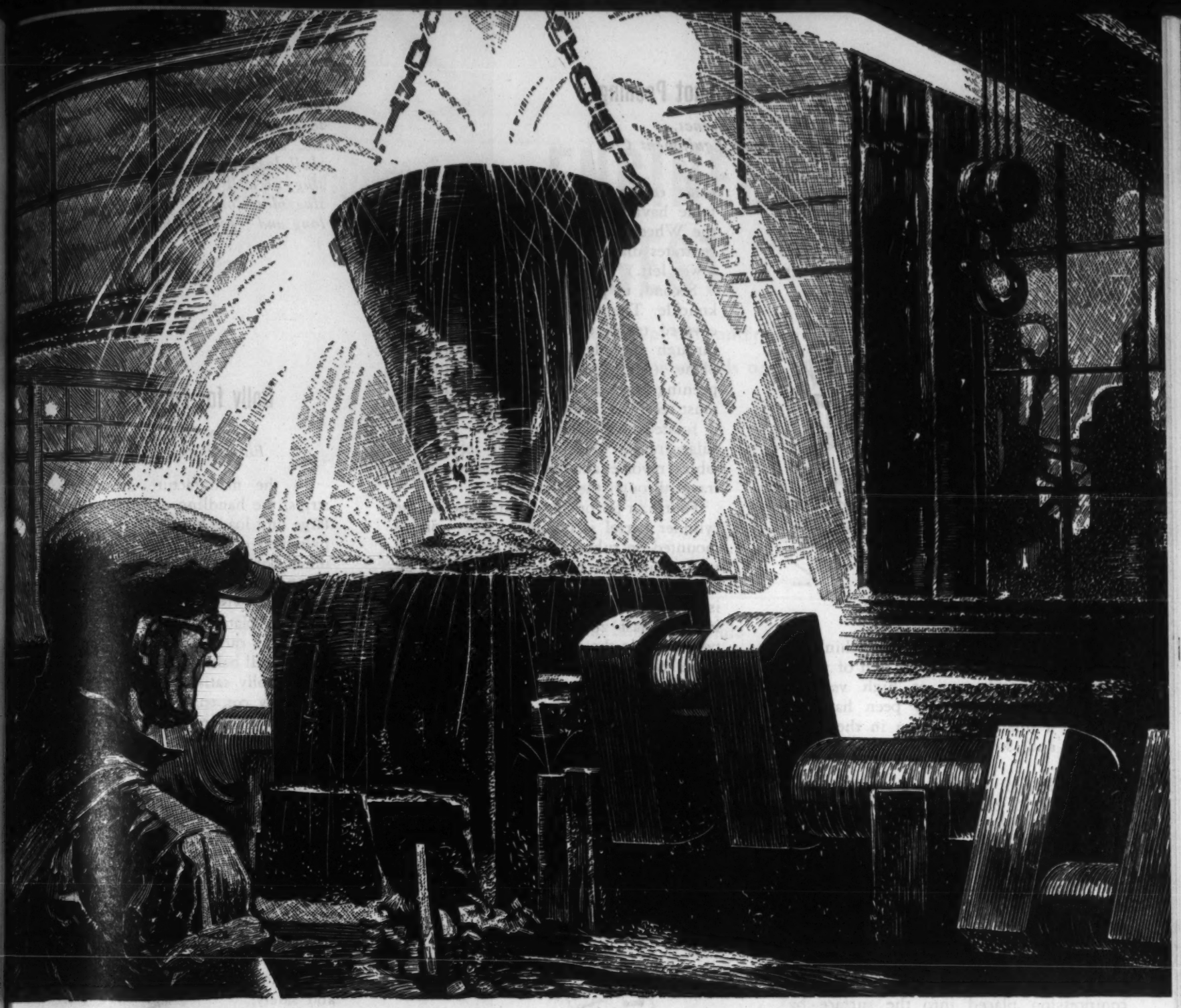
A new boring bar solved this problem. The chamfering is done by a carboloy tool, which is mounted on a pin in a slot in the boring bar. Under the handle, at the back end of the tool, there is a spring that keeps it clear during the boring operation.

With this new set-up, the cross slide is set and locked in the proper position and the holes are bored to size. After the



hole is bored and the feed is at rest, the operator hand feeds the chamfering tool by pressing on the hand lever. The amount of chamfer is controlled by a stop under the back end of the tool.

The use of this tool has increased production of the part by eliminating the scrap and reducing the time required for the operation.



SAVED FROM THE SCRAP PILE

Breaking a large crankshaft can be a serious matter these days—but Thermit welding can make it much less serious.

Instead of weeks of "down time," while waiting for a new shaft, only 48 hours or less may be required to make the repair with Thermit welding.

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Use Thermit welding to save broken crankshafts, housings, axles and other heavy parts—and for fabrication of very heavy units. Thermit welding may be done on your own premises or at one of our plants at Jersey City, Chicago, Pittsburgh or South San Francisco. Send for new booklet, "Thermit Welding" which explains the process in detail. Metal & Thermit Corporation, 120 Broadway, New York 5, N. Y., Albany, Chicago, Pittsburgh, South San Francisco, Toronto.

Thermit Welding

Handling Parts for Shot Peening

by K. H. Barnes,
American Foundry Equipment Co.

Shot peening of metallic surfaces to prevent formation of fatigue cracks under tension stress has now been applied to a wide variety of work. There are by now varied methods to secure peenage coverages of all surfaces, or limited areas.

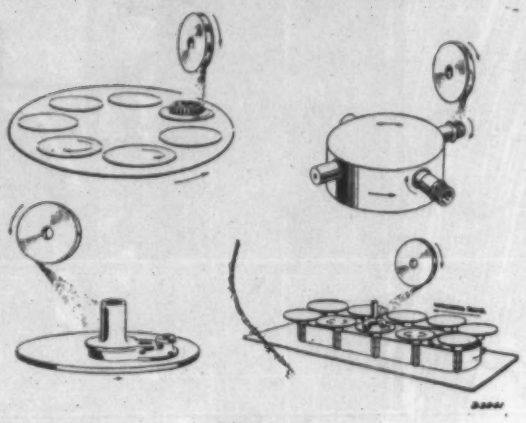


Figure 1

Basically, shot peening is stretching the surface of a metal part by a rain of round metallic shot thrown at high velocity. Each shot acts as a tiny peen hammer, making a small indentation in the metal surface and stretching it radially as it strikes.

Stretching of the top fibers, in a layer that is 0.005 to 0.010 in. deep, places them in residual compression, while the fibers underneath, not being deformed, are in a state of tension. When load is applied to this part so that the stress due to the load would place the surface fibers under a tension stress, the resultant stress in the surface of that part will either be a lower tension stress or possibly remain a compression stress due to the residual compression placed into the surface by the shot peening, and fatigue cracks will not start. It is axiomatic that fatigue failures generally result from tension and not from compression stresses.

Shot peening is best done by the airless blast method, the shot being thrown against the work by a combination of centrifugal and tangential forces. The Wheelabrator blast unit is a high-speed bladed wheel that uses centrifugal force, instead of compressed air.

The shot is fed to the center of the wheel and eventually reaches the bladed section of the wheel. Here it is picked up by the inner ends of the throwing blades and is gradually accelerated in its passage to the periphery of the wheel. The final throwing velocity is the resultant of radial and tangential velocity.

Change in direction of the blast stream is through positioning of the control cage, which changes the location of the opening. Variations in speeds and peening intensities are obtained by using wheels of different diameters, widths and speeds and by various shot sizes. One must handle the work in the correct relation to the blast stream.

Let's consider seven problems in peening. The first is to shot peen the fillet of a differential hub to prevent fatigue cracks on the fillet. The hub is placed in the exact center of a power-driven rotating table having a fixed position relative to the Wheelabrator so that the stream concentrates directly upon the fillet. (Fig. 1, lower left.)

Second, to peen the fillet of a steering knuckle. The work is mounted on rubber-covered tables that rotate as they travel through the blast zone in a horizontal plane. (Fig. 1, lower right.) Third, in peening bevel gears the roots of the teeth must receive adequate coverage. The work is rotated about a vertical axis, with circular travel. (Fig. 1, upper left.) The tables revolve automatically as the gears travel through the blast zone.

Fourth, a portion of an airplane engine cylinder barrel is involved. The work is mounted on rubber-covered spindles fitted to a cylindrical turret, controlled by an automatic timing and indexing mechanism, whereby each spindle is positioned in the blast zone for a predetermined period while the spindle rotates. (Fig. 1, upper right.)

Fifth, a torsion bar (replacing leaf springs on tanks, buses and trucks). This illustrates the rotation of the work about

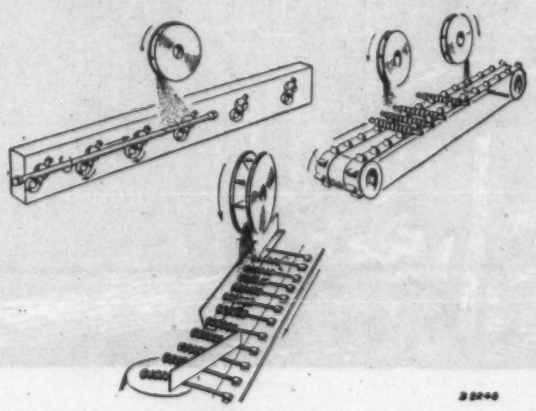


Figure 2

a horizontal axis, with straight line travel parallel to rotation. The bar is rotated and carried through the blast by a series of skewed-dished rolls. (Fig. 2, upper left.)

Sixth, small valve springs (Fig. 2, lower) are rotated about a horizontal axis, with horizontal travel at right angles to the axis of rotation. The springs are mounted on steel bar fingers fitted to an endless rubber conveyor belt. The springs are held on the fingers by an angle guide, which also rotates the springs as they pass through the blast.

Seventh, two milled ends of tank tread pins which require straight line travel with no rotation. The pins are carried on an endless rubber belt conveyor and are held on the belt by special clips. Each end of the pin is peened by a separate Wheelabrator unit.

In the manufacture of cement or refractory material for metallurgical furnaces in kilns, an obstructing "ring" or crust frequently forms and must be removed. Often there were many shutdowns while the kiln cooled enough for a man to enter to eliminate the ring. Western Cartridge Co. has developed a "Jumbo" shotgun shell loaded with a 3-oz. cylindrical lead slug, as well as a gun. Bang!—And the slug blows out the ring, thus eliminating long and frequent shutdowns.

—News Release from Steve Hannagan

Dolly for Long Materials

by C. B. Cook,
Elwell-Parker Electric Co.

In the manufacture of landing mat strips, the handling and transportation of large unit loads by electric industrial trucks presented difficulties due to the ungainly dimensions of the material. Aisles were not wide enough to permit carrying the strips crosswise of the platform, and the standard platform was not long enough to permit carrying them lengthwise and have a well balanced load.

A wholly satisfactory solution was obtained by constructing an auxiliary dolly mounted on casters, which can be moved about manually to a limited degree and can also be transported rapidly between various operating departments by the electric truck.

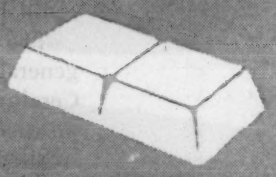
The dolly was made by welding flame-cut parts of standard flat rolled shapes. A steel fitting bolted to the forward end of an Elwell-Parker power truck platform provides for a pin connection between the base frame and the truck. The truck lifts only one end of the dolly and can either push or pull the load through narrow aisles and around corners with ease and safety.

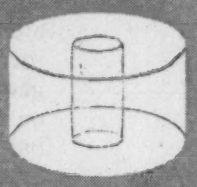
This arrangement for handling loads of long pieces has the advantage that the truck can be made quickly available for handling other types of loads on skids in the same plant. The super-structure illustrated was designed especially for handling landing mat strips. It can easily be modified to accommodate other types of material in long lengths, such as tubes, bars, small trusses and the like.

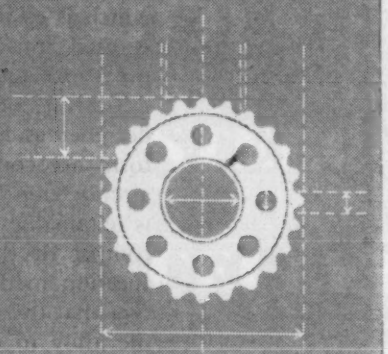
Metal-Working Industries

Edited by Kenneth Rose

Engineering Editor,
Metals and Alloys







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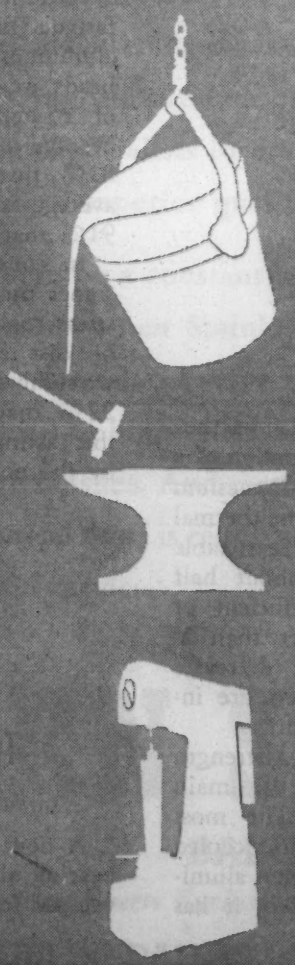

ENGINEERING DIGEST

A selection of outstanding articles on
engineering materials and processing methods

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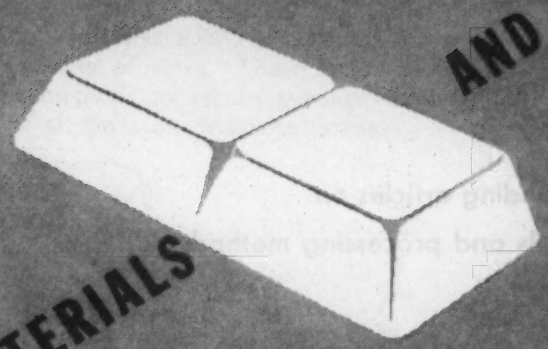

METALS and ALLOYS

Engineering properties and applications of carbon, alloy and stainless steels, irons and nonferrous metals and alloys. Selection and evaluation of metallic materials for engineering service. New alloys and modifications.

Light Metals for Marine Engines

Condensed from "Metallurgia"

One of the most prominent uses of aluminum in engines has been for pistons in reciprocating engines. Y Alloy and Lo-Ex have been used in this application, although the former is the more popular. Choice should not be based upon room temperature strength or short time elevated temperature strength, since creep strength and fatigue strength at temperature are the most important characteristics.

However, it is interesting that Y Alloy, which was originally picked on the basis of its short time elevated temperature strength, also has the best creep strength and fatigue strength at 300 C. of any of the light alloys in common use. Sometimes high-silicon aluminum alloys are used, not due to their low coefficient of expansion but because they lend themselves better to the formation of a hard wear-resisting anodic film. Magnesium alloys are not used because: (1) the thermal conductivity of cast alloys with reasonable room temperature strength is about half that of Y Alloy; (2) the coefficient of expansion is about 25% greater than Y Alloy; and (3) their strength decreases much more rapidly as the temperature increases than do the aluminum alloys.

Good thermal conductivity and strength at operating temperatures are the main requisites for cylinder heads. The most readily available coolant for liquid cooled heads is sea water. Therefore, when aluminum alloy cylinder heads are used, it has been customary to use a closed circuit of fresh water for cooling.

It is suggested that trials be made of light alloys capable of resisting sea water, such as the aluminum magnesium alloys of the Birmabright type, which have been successfully used for sea water cooled exhaust manifolds. In this case, the inconvenience of creating a fresh water cooling system could be avoided.

The principal uses of aluminum forgings, generally of the Y Alloy, RR 56, RR 59, Ceralumin F, and Ceralumin 22 types, are pistons (forged pistons are confined to smaller engines), connecting rods, rockers, rocker operating rods, fan blades, small caps and covers. Aluminum alloy connecting rods are particularly valuable in decreasing the inertia. It is possible to run hardened gudgeon pins and even crankpins directly on forged aluminum alloy connecting rods, but separate inserted bearings are preferable.

A 3 to 5% magnesium-aluminum alloy, which is easily welded, rolled and extruded, is used for chequer plates, handrails, fuel pipes and fuel tanks.

Castings offer considerable freedom to the designer as far as limitations of shape and form are concerned. The castings used in aircraft engines have shown the quality that is obtainable with new methods of technical control in the foundry and improved inspection methods. It is particularly important that the designer have the properties of the alloy in the form in which he expects to use it rather than in separately cast test bars.

A comparison of the tensile strength and fatigue properties of engine castings of aluminum alloys (crank cases and cylinder heads weighing from 16 to 350 kg.) and of 25-mm. test samples showed that the average tensile strength of the castings was 81% that of the test bars and that the average fatigue strength of the castings was 91% that of the test bars.

In considering fatigue strength, the designer must take into account the effect of stress concentrations. The notch sensitivity of cast aluminum is less than that of wrought aluminum. A reduction of 7 to 22% may be caused by irregularities in the casting skin in addition to that caused by the notches.

—A. J. Murphy, *Metallurgia*, Vol. 31, Jan. 1945, pp. 124-128.

Tri-Metal Bearing Alloy

Condensed from "The Iron Age"

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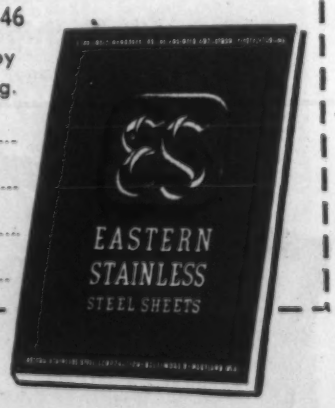

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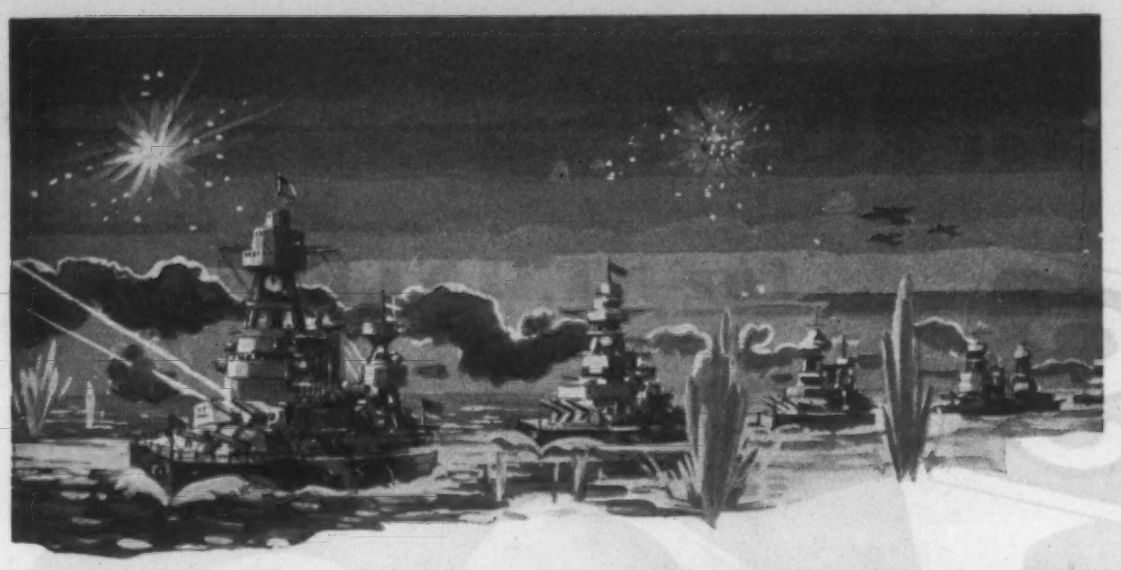

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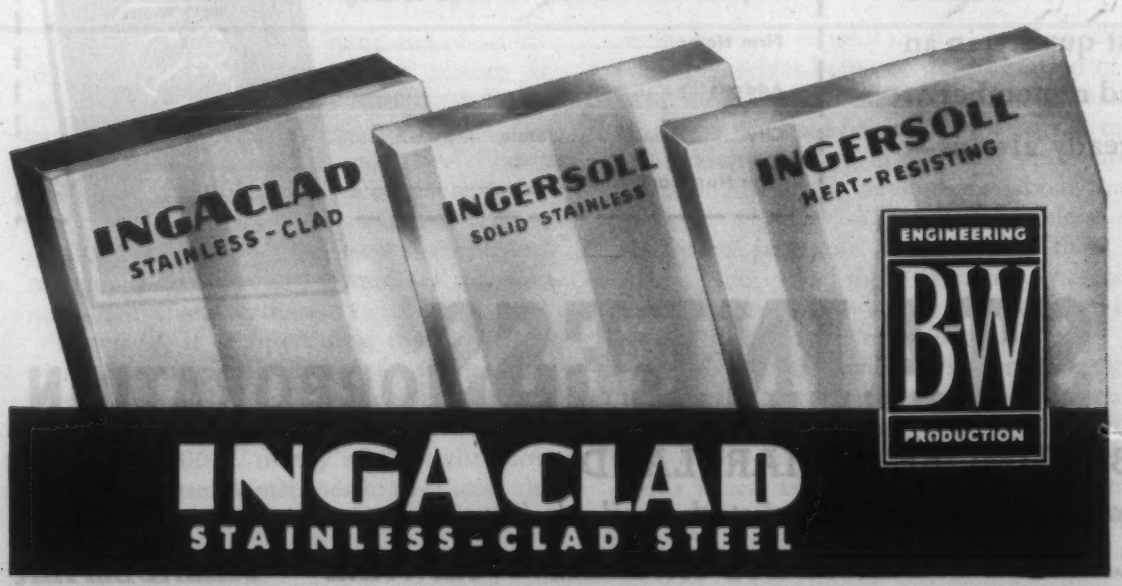

prevents segregation of the lead and resultant fatigue. Although costlier than cadmium bearings, the new "tri-alloy" will give two to three times the service life of conventional bearings, even under the most severe conditions.

In road tests on heavy-duty Ford trucks, bearings and crankshaft journals showed no measurable wear after 50,000 miles of service. In other cases, wear up to 0.0005 in. has been recorded after 40,000 to 50,000 miles of use.

The process consists of depositing the bearing alloy on both sides of a low carbon steel backing strip so as to make a double-face floating type bearing. The steel strip is 2 in. wide and 0.075 in. thick, and is fed from coils through pot-type furnaces. Thickness is controlled by a pair of molded graphite dies encased in a cylindrical boot. Dies last about 35 hrs.

The boot is suspended beneath a pot containing molten alloy and is water cooled at its lower end to freeze the metal on the strip, which emerges at about 200 F. In passing through the molten bath, the strip is preheated to prevent the alloy freezing on it until it reaches the lower end of the die. Knurled rolls pull the strip vertically through the pot.

A careful check is kept on bonding and analysis of the mix. Bonding is tested by hammering the strip double and inspecting for adhesion.

The overall scrap rate stands at 5 to 7%, due to material defects.

—*Iron Age*, Vol. 155, Mar. 29, 1945, pp. 50-51.

Creep Strength of Zinc Sheets

Condensed from "Zeitschrift für Metallkunde"

The differences in packet-rolling and strip-rolling of zinc alloys have been investigated, with particular reference to the creep strength and the previous treatment of the sheets. The investigated materials were commercial zinc, special quality zinc, and alloys of the type zinc-copper-manganese, zinc-copper-antimony, zinc-aluminum, and zinc-aluminum-copper.

Creep velocity was tested at room temperature as a function of load over a time of about 1400 hr. The creep strength of packet-rolled sheets is, except for commercial zinc, considerably higher than that of the strip-rolled sheets. This is ascribed to the usual higher reduction in strip-rolling as compared with packet-rolling.

It was also found that, in general, strip-rolled sheet crystallizes with considerably finer grain than packet-rolled strip, a result that conforms to the creep strength test. It is assumed that the creep strength of packet-rolled materials can still be increased by suitable working conditions.

The creep strength in kg. per sq. mm. for a year is for all materials 1.0 to 2.7 for 0.5% total elongation, and for 1% total elongation 1.5 to 3.4%.

—W. Hofmann, T. Bin Ley & H. Hanemann, *Z. Metallkunde*, Vol. 36, Feb. 1944, pp. 43-45.

...they're all MO-MAX

Every one of the **molybdenum-tungsten** high speed steels listed below is made according to a genuine MO-MAX formula. To insure top performance in all types of cutting tools, specify one of these MO-MAX steels.

ALLEGHENY LUDLUM STEEL CORPORATION	"LMW"
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BRAEBURN ALLOY STEEL CORPORATION	"MO-CUT"
CANADIAN ATLAS STEELS, LTD.	"MOHICAN"
CARPENTER STEEL COMPANY	"STAR MAX"
COLUMBIA TOOL STEEL COMPANY	"MOLITE 8"
CRUCIBLE STEEL CO. OF AMERICA	"REX T-MO"
FIRTH-STERLING STEEL COMPANY	"HI-MO"
HENRY DISSTON & SONS, INC.	"DI-MOL"
HALCOMB STEEL COMPANY	"REX T-MO"
JESSOP STEEL COMPANY	"MOGUL"
LATROBE ELECTRIC STEEL COMPANY	"TATMO"
SIMONDS SAW & STEEL COMPANY	"S. T. M."
UNIVERSAL-CYCLOPS STEEL CORPORATION	"MO-TUNG"
VANADIUM-ALLOYS STEEL COMPANY	"8-N-2"
VULCAN CRUCIBLE STEEL COMPANY	"VUL-MO"

For the full story on MO-MAX **molybdenum-tungsten** high speed steels—their physical properties, their advantages, and how to heat treat them—write today to Department C for the new 1945 MO-MAX Handbook.

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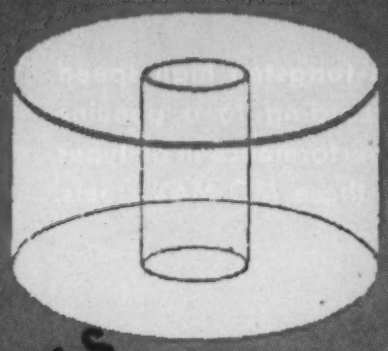


MATERIALS AND DESIGN

NONMETALLIC MATERIALS

Design-uses of plastics, plywood, fibre, glass, rubber, ceramics, etc. as engineering materials. Composite metal-nonmetal combinations. New types and forms of nonmetallic materials.

Furfural Resins as Sealers

Condensed from "Plastics"

Furfural resins, considerably used in adhesives, have been developed as sealing materials for porous surfaces, particularly wood and concrete. They may be applied completely free of solvents or volatile matter, the liquid resin being self-polymerizing upon addition of catalyst.

The resin coating sets up firmly shortly after application. Polymerization continues for several days. After the resin is fully cured, it possesses exceptional resistance to water, and to acids and most chemical solvents. Water absorption is less than 0.1% in 24 hr. Aircraft plywood has been sealed against aviation gasoline by coating with two coats of the furfural resin.

When dissolved in acetone, the resin may be used as a special surface coating. It forms a tough adherent film after evaporation of the solvent. Both wood and metal have been treated with this protective material. For maximum resistance to water and solvents, however, the liquid plastic without solvent is the better.

Tests seem to show that the sealing material would be suitable for coating wooden or concrete storage tanks to prevent loss of various fluids. Resistance is especially good against water, gasoline, and isopropyl alcohol.

The coatings are at present limited to dark colors, although some pigmentation may be accomplished.

A use that has been widely adopted by the aircraft industry is as an impregnating agent for plaster of Paris. Absorption of up to 50% of resin in dry plaster of Paris has been found to increase compression strength by about 400% when properly cured, while flexural strength increases about 700%. The impregnated plaster is given increased dimensional stability and freedom from shrinkage, and becomes much more waterproof.

Certain tanks formed of laminated plastics use the furfural synthetic as a sealer also. It possesses the power of wetting and even penetrating solid surfaces of various kinds.

As an adhesive the material is supplied as a low-temperature setting type, containing 50% of volatile matter, and as a high-temperature setting material, containing no volatiles. The latter type is used for bonding metals, and for pretreatment of special plastics.

—John Delmonte. *Plastics*, Vol. 1, Oct. 1944, pp. 39-40, 99.

Plastics Materials for Aircraft

Condensed from Paper of the Society of Automotive Engineers

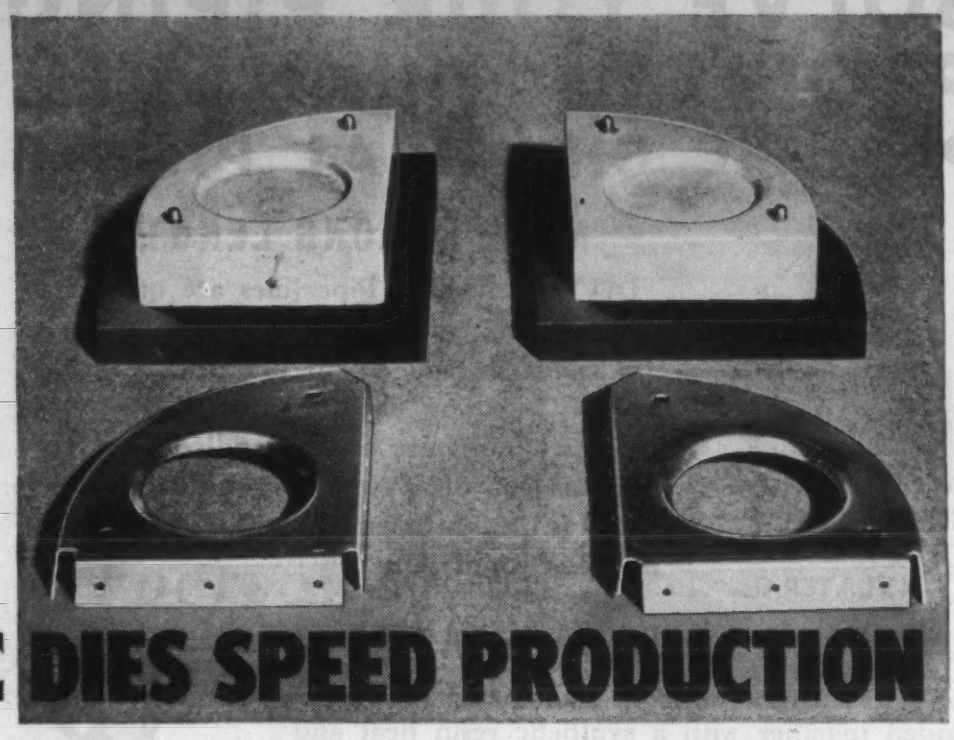
If the engineer is to use plastics materials in stressed parts, more mechanical data will be required than is at present available. These materials differ from metals in behavior—they seldom exhibit a marked yield point, they tend to creep at normal temperatures, and they fail to obey Hooke's law precisely.

Thermoplastics have been used in aircraft construction for windows and gun sighting panels. Difficulties in service have been considerable. Methyl methacrylate is notch sensitive, crazes, and has poor abrasion resistance compared to glass. Cellulose acetate is inferior to methyl methacrylate in optical properties, and has poor dimensional stability.

In designing, the utmost care should be taken in the method of mounting. Holes should not be drilled in the material if glued rubber bearing plates and metal clamps can be used. Optical uniformity is a responsibility of the designer as well as the fabricator.

We are rapidly approaching the day when plastic materials will cover the range from rubber-like to hard, rigid materials. Thermoplastics have found use in power distribution and high frequency electrical systems as molded insulators. The effects of high relative humidities and low temperatures are limiting design factors.

Polyetnylene and polystyrene are little affected by high humidity. All insulating materials based on carbon have severely



CAST PLASTIC DIES SPEED PRODUCTION

This war has advanced plastics' progress by decades. Many new and unusual developments . . developments that border on the miraculous, give the post-victory manufacturer every opportunity for success. Typical of these developments are Durez casting resins . . designed to reduce the time and cost consumed in conventional die-making . . designed to speed production.

Durez casting resins lend themselves readily to cast forms for hydro-press operation. To make a forming die for a hydro-press, the original pattern can be made of wood and a plaster cast mold made from this. The resin is poured in . . . without the need of a core if the part is small . . . and cured. It is then ready for immediate use. The above-illustrated cast plastic dies (and parts which were formed from them) produced hundreds of pieces which were without flaw.

Holds Tolerances

Tests have shown the Durez casting resin used for these dies may be sawed easily, that it drills like hard maple wood, that it will not hold heat or be softened by it, and that it will not ignite. Standard wood or metal working equipment may be used to work it. When it becomes necessary to replace a conventionally made die, it has been found that it is not necessary to wait for a die to be remade in that material. Instead, in some instances, a part formed on the original die may simply be filled with a casting resin and the plastic cured into a usable die in a matter of a few hours. Furthermore, casting resins are particularly adaptable where the form or die has in it joggles or other similar insets which must be machined in the conventional die material. No such machining is necessary in the plastic die. The liquid resin follows the contours of the part exactly and holds those contours to predetermined tolerences.

Other Uses

A few additional uses for these resins are stretch-press dies, jigs, assembly and holding fixtures, foundry patterns, and masking shields for plating.

Folder Available

As specialists in the production of phenolics during the past quarter century, Durez technicians have gained an enviable record for developing plastics that fit the job. This background includes molding compounds, industrial resins and oil soluble resins. The benefits which this wealth of experience can provide are available at all times towards the development of practical industrial applications. Write for authoritative folder on casting resins. Durez Plastics & Chemicals, Inc., 276 Walck Road, North Tonawanda, N. Y.

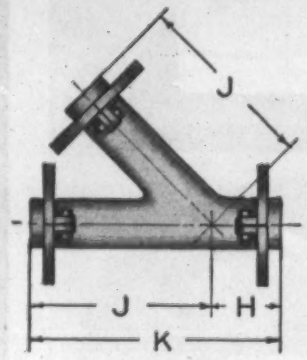
DUREZ

PHENOLIC RESINS

- MOLDING COMPOUNDS
- INDUSTRIAL RESINS
- OIL SOLUBLE RESINS

PLASTICS THAT FIT THE JOB

SOLVE YOUR PIPING PROBLEMS with HAVEG PLASTIC CHEMICAL PIPING

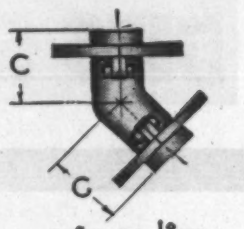


45° LATERAL

MADE IN LONG LENGTHS

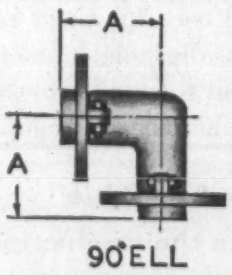
HAVEG Chemical Pipe lines are quickly installed with a minimum number of joints. In standard sizes 1″ to and including 12″ HAVEG piping is furnished in ten foot lengths. Joints are easily handled since connections are of a simple split flange design which is quickly assembled and assures a positive leak proof joint.

A TOUGH non-brittle PLASTIC



45° & 22½° ELL

HAVEG chemical piping is made of asbestos fibres bonded together with a synthetic resin heat and pressure. HAVEG piping is strong, tough and resilient. It requires no special handling as it is not brittle. It is chemical resistant THROUGHOUT ITS ENTIRE MASS, therefore surface scratches or even deep gouges do not impair its chemical resistance. Should cracks or breaks occur, they are readily mended, on the job, with HAVEG repairing cement. HAVEG piping is unaffected by rapid temperature changes and can be used continuously at temperatures as high as 265° F (130° C).



90° ELL

READILY CUT AND FITTED "on the job"

HAVEG piping is supplied in standard 10 foot lengths complete with connections, expansion joints, fittings and valves where chemical pipe lines can be blueprinted before installation. Where lines cannot be planned in advance, or for some other reason it is desirable to erect lines as installation of tanks, towers and other equipment proceeds, HAVEG is readily cut and fitted "on the job." HAVEG is readily cut by using a band, circular or hack saw. It is conveniently machined about the same as brass, using high speed and slow feed. It may be machined dry, not requiring lubricants or water.

HAVEG bulletin F-4 gives complete data on how to specify, erect and service HAVEG piping.

Send FOR TECHNICAL BULLETIN

HAVEG chemical piping is made in standard sizes ½″ to and including 12″. The illustrations shown here are from the piping section of bulletin F-4, which gives complete engineering data on HAVEG pipe, valves, fittings, pumps and other accessories. You can design complete installations from this data. Send today for Bulletin F-4.

HN-1-45

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limited thermal stability, but replacement of carbon by silicon increases thermal resistance.

Thermosetting plastics parts for aircraft construction are produced by molding, laminating, or by mechanical working of plates, tubes, or bars. Post-forming of laminated sheets is used to produce many parts.

While all organic materials are affected by changes in temperature and humidity, the effect of elevated temperature is much less marked in the case of the thermosetting plastics than in the thermoplastic materials. High impact stresses and strong deformation should be avoided with thermosetting parts produced with certain fillers, such as wood flour. Linear thermal expansion of molded parts is two to four times that of light alloys and steel. Thus, connections and molded inserts must be properly designed.

Addition of chopped fibers, cord, and woven fabrics to thermosetting materials enhances their properties to a point where they may be considered for primary and secondary structural applications.

—Russell M. Houghton. Paper, Soc. Automotive Engineers, Oct. 1944 meeting. 7 pp.

An Expanded Polystyrene

Condensed from "Modern Plastics"

A recently developed plastic material, offered under the trade name Styrofoam, offers unique properties. By expanding the plastic polystyrene into a non-permeable multicellular mass consisting of small pockets of air in polystyrene cells, a very low-density material is obtained. Volume is increased 42 times.

While a variation in cell size and in wall thickness may be obtained, producing a range of densities, the only expanded polystyrene commercially available at present weighs approximately 1½ to 2 lb. per cu. ft. Like the parent material, it is odorless and tasteless.

One of the outstanding properties of the material is low density. Cork or balsa wood are four to 10 times heavier than the expanded polystyrene. It is highly resistant to rot, decay, and mold growth. It retains its strength at low temperatures, and is not affected by exposure to the weather. Polystyrene is a thermoplastic synthetic, but is usable at temperatures as high as 170 F.

While the polystyrene is flammable, it is believed necessary to apply an open flame to it before combustion will take place. Burning is slow, and the fire is easily extinguished.

The material may be bonded to itself or to wood, metal, and various other materials by the use of casein or other cold-setting resinous glues.

Military and naval life rafts, boats, and floats are making use of the extreme lightness of the material at present. Its unusual electrical properties, thermal properties, and moisture resistance find other military applications.

Prospective postwar uses are expected in the fields of boating, aviation, refrigeration, decorative window and counter displays, movie sets, and toys.

—D. W. McCuaig & O. R. McIntire. *Mod. Plastics*, Vol. 22, Mar. 1945, pp. 106-109, 202.

CONTACT

Lumarith* Plastics

for items of personal use

LOW THERMAL CONDUCTIVITY is just a laboratory way of saying that Lumarith plastics are inviting to the touch in all temperatures. It explains one of the many reasons why these jade-like thermoplastics are used so frequently in applications involving personal contact and handling: electric shaver housings, hardware, tool handles, telephone handsets . . .

Lumarith molded and fabricated items have a uniform surface texture and smoothness that actually improves with handling. They are odorless, tasteless and non-toxic, and can be produced in a limitless range of colors, color densities and transparencies.

Would you like to know more about these modern plastics? Write for Product Designer's Booklet, or refer to Sweet's Catalog. Celanese Plastic Corporation, *a division of Celanese Corporation of America*, 180 Madison Avenue, New York 16, N. Y.

A Celanese Plastic*

*Reg. U. S. Pat. Off.

Information for Product Designers

Toughness is characteristic of all Lumarith plastics. They have excellent colorability, water resistance, dielectric strength, lightness, uniformity and stability—are interchangeable in many applications. The different Lumarith types and formulations accent particular physical properties in the following manner:

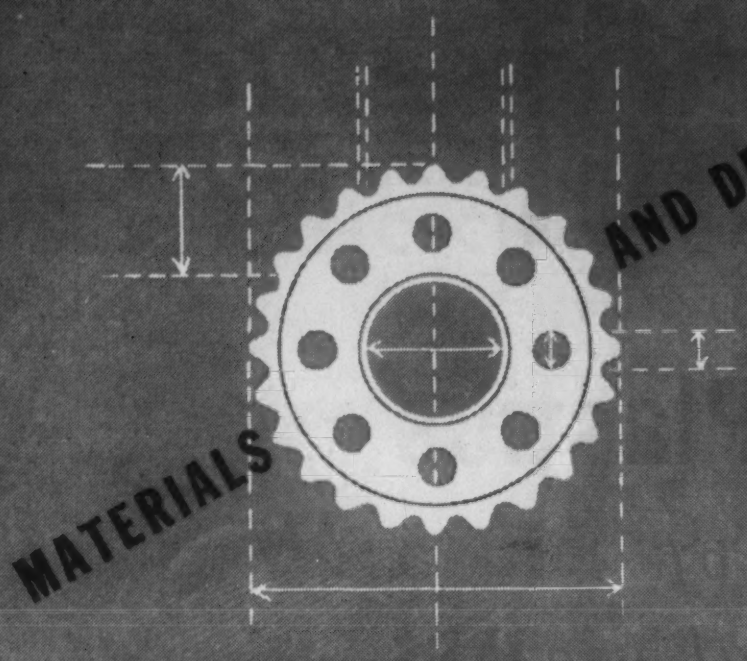
LUMARITH C.A.
Cellulose acetate. The most versatile of the cellulosics . . . ideal in applications requiring balanced physical properties . . . superb color.

LUMARITH *X*
High acetyl cellulose acetate. Provides added dimensional stability and moisture resistance, with superb color.

LUMARITH E.C.
Ethyl cellulose. Superior toughness at temperature extremes, plus lightness and form retention.

CELLULOID
Cellulose nitrate. Color, economy and all around toughness maintain the popularity of this "first plastic". . . used in volume for fabricated items.

Success with plastics depends on the proper selection of plastic type and formulation. Our technical staff is at your service.



GENERAL PRODUCT DESIGN

Selection, applications and design of parts made by various fabricating methods or made of special materials. Properties and uses of finishes and coatings. Design and materials for specific products or fields. General engineering design trends or principles.

only by wet grinding with high-speed grinding wheels. Now, even with routine grinding, accuracies of ±0.01 mm. are attained. A parallelism of ±0.03 mm. in 100 mm. can be obtained in grinding plane surfaces, while with axles and shafts (usually centerless grinding) deflection can be limited to 0.03 mm. over a length up to 700 mm. Holes of 4 mm. are the smallest that can be internally ground and to accuracy of ±0.03 mm. In thread grinding, sharp threads are preferable to rounded-off ones.

Surfaces to be ground should be kept as small as possible; clamping the piece is facilitated by providing small bosses for resting the piece; fillet radii less than 0.6 mm. cannot be produced. Wet or dry pressing in steel molds is the most common method of fabrication.

In wet pressing, an excess of material is placed in the mold, with surplus allowed to escape. In dry pressing, the exact amount is introduced, the mass being compressed to one-half its original volume. It has greater density and better electrical and mechanical properties, but flows much less easily, with recesses and thin walls impossible of manufacture.

Owing to absence of shrinkage, the dry pieces have greater uniformity and accuracy of dimensions. They are more solid when lifted from the mold, making dry pressing better for automatic mass production.

When designing a piece to be produced by extrusion, one should avoid sharp edges or corners, while a uniform wall thickness must be maintained to assure uniform flow velocity through the nozzle area.

—J. Wallich. *Zeitschrift des VDI*, Vol. 88, Jan. 8, 1944, pp. 9-14; as abstracted in *Engineers' Digest* (British), Vol. 6, Feb. 1945, pp. 31-33.

Small Ceramic Parts

Condensed from "The Engineers' Digest"

Several ceramic materials have been developed in late years that satisfy strict requirements as to heat resistance, electric strength, low dielectric loss and permanency of physical dimensions. Properties approximate high grade porcelain used for electrical purposes.

Ceramics used in high frequency technique are preponderantly of the magnesia-silica type, which can be molded by any ceramic process and can be bonded with metallic conductors without cements or glues. They can be fused to glass, with joints liquid-, gas- or vacuum-tight.

Ceramic components are shaped fundamentally differently from metals. They are shaped from plastic or liquid masses in the cold state, with composition closely controlled. After firing, a ceramic component gets its final shape, unalterable by bending. Allowances must always be made for shrinkage. Thus, bolt holes should be elongated, not round, to allow for shrinkage.

Machining of fired pieces can be done

Die Castings in Door Controls

Condensed from "Die Casting"

Controls for the doors of transit vehicles must be fast operating, safe and dependable. As this equipment guides the movement of boarding and alighting passengers, it must obviously be designed and built to afford them the maximum protection, in order to hold the operating company's accident costs to a minimum.

An impressive development is the multiple door control on the New York subways. A train of twelve or fifteen cars, each with four sets of doors in operation, are all controlled by one man.

A multiple air system may appear very complicated, yet it is really simple. Each door has its own engine and a multiplicity of individual engines can be readily hooked

up into one system. The zinc alloy die cast parts are identified as follows: An unassembled plunger, speed control valve body, cylindrical cap, foot castings and bracket. These castings are used substantially as received. On the plunger, cap and speed control body a few holes are tapped. Parts are assembled for a complete bracket with pins, cotter keys and bolts.

The two piston chambers of the differential door engine are fed through two ports. To open the door, air pressure must be exhausted from the larger piston chamber, when the constant pressure within the smaller piston chamber will move the piston inward to a door-open position.

To prevent the door from slamming, it is necessary to check the movement of the door engine piston just before it completes the stroke in either direction. It is quite obvious that die castings such as plungers must be airtight to function properly. Die castings do not leak.

A windshield wiper is another product that has been built around die castings. The housing is an interesting casting because of its peculiar shape, the multiplicity of bosses that must be sound, the male die cast thread and the cast in bronze bushings that serve as bearings for the drive shaft that operates the wiper blade.

These castings require but very little machining except occasional tapping of internal threads. Their use has saved the manufacturer much time and money.

—J. R. Newkirk. *Die Casting*, Vol. 3, Apr. 1945, pp. 35-37, 42-43.

Aluminum Box Cars

Condensed from "Railway Age"

Three aluminum box cars, built for the Alton, Rock Island and M. & St. L. railways, incorporate complete aluminum superstructures, including side frames and sheathing, ends, roofs, doors, etc. Reynolds aluminum alloy R-301 predominates.

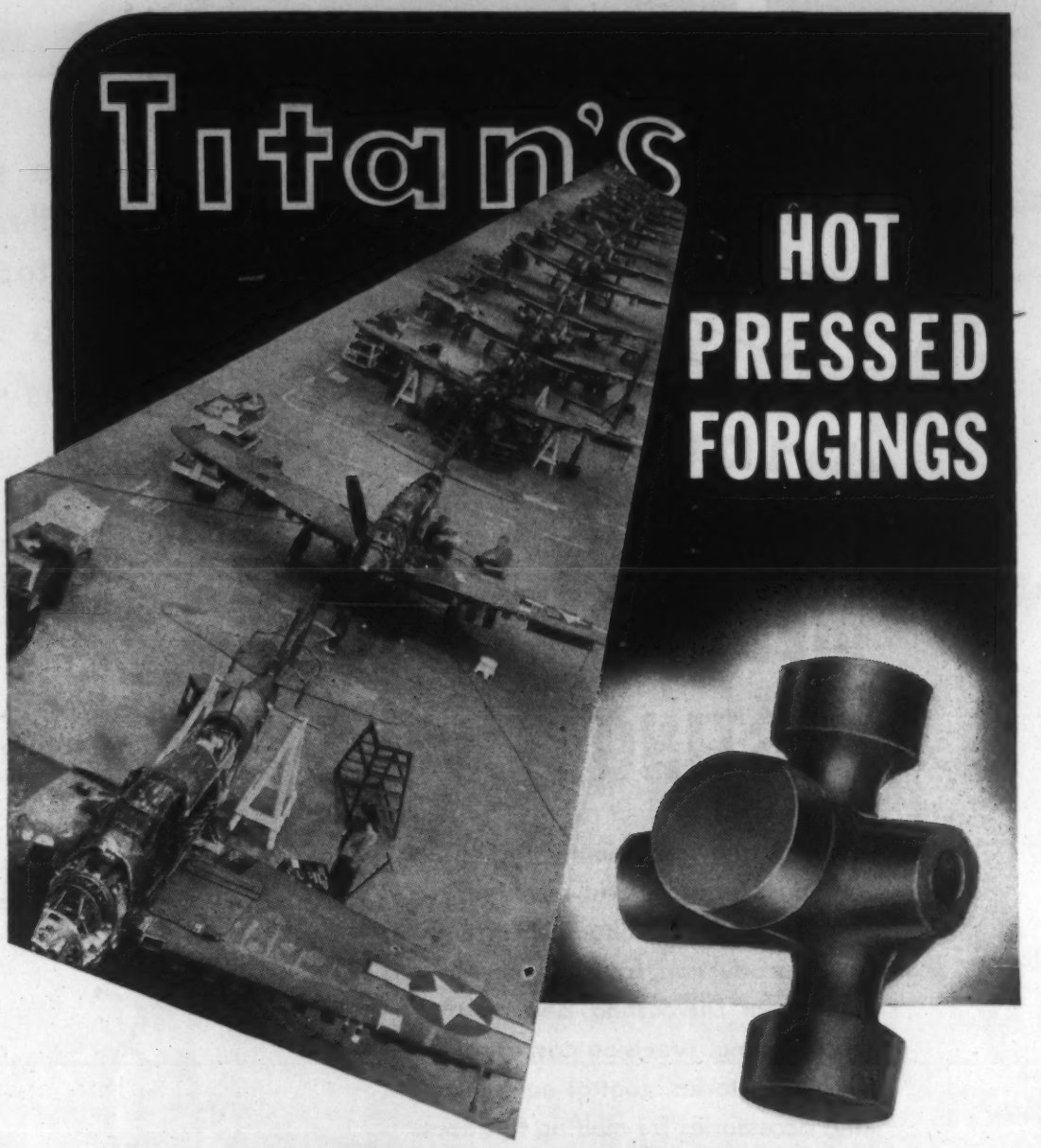
The underframe of these cars comprises welded steel construction with a carbon-steel center sill, alloy-steel bolsters and cross bearers, steel center plates and draft lugs. Longitudinal floor supports are made of aluminum. The door track and fixtures and the safety appliances are made of steel.

The car underform is a composite structure, but primarily steel. Steel underforms are painted with regular primer paint and one coat of car cement. Aluminum parts of the underform are painted with a zinc chromate primer, and one coat of car cement is applied.

The aluminum alloys employed besides R-301 are 17 S-T for extruded shapes, R 303-T275 for follower plates, A 17-S-T for rivets, and R-303-T 315 for Holdrite packing material.

An interesting advantage of the use of aluminum floor bolts to hold the tongue-and-groove flooring is that the car may be loaded with explosives without covering the bolt heads as ordinarily required by the I. C. C. Bureau of Safety regulations.

—*Railway Age*, Vol. 118, Mar. 10, 1945, pp. 444-447.



ARE USED IN AMERICA'S WAR PRODUCTION

TITAN'S HOT PRESSED PARTS are being used in huge quantities in many types of war materiel needed for victory. Our entire output of Hot Pressed Parts is allocated to meet the diversified requirements of our armed services.

While we have kept pace with the fast-moving developments that have been responsible for America's superiority in armament, peace will find Titan Hot Pressed Parts readily adaptable for use in new and improved products. They will help meet post-war competition on every count of quality, production, engineering and cost.

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Quality Alloys By Brass Specialists

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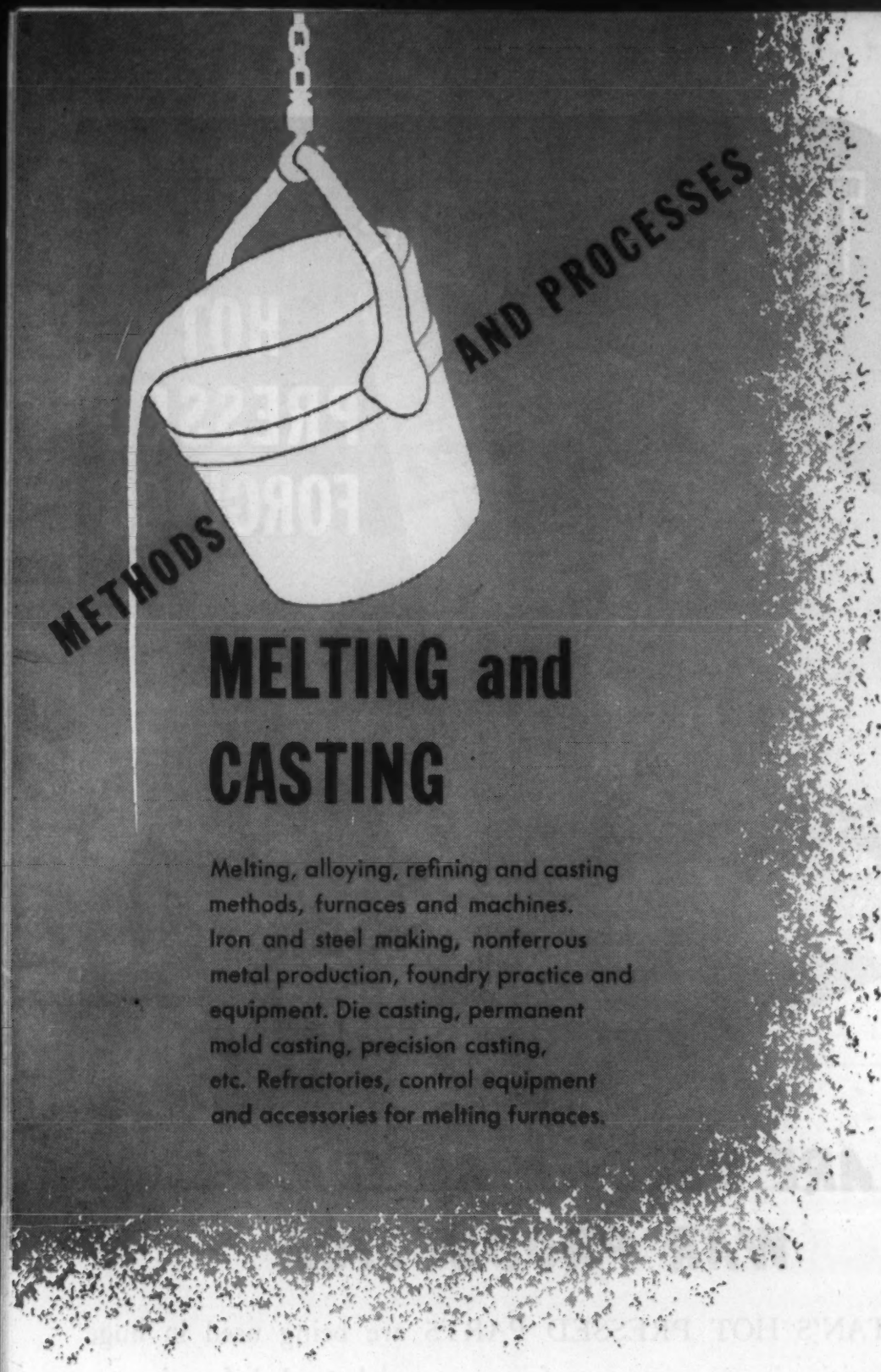


METHODS AND PROCESSES

MELTING and CASTING

Melting, alloying, refining and casting methods, furnaces and machines. Iron and steel making, nonferrous metal production, foundry practice and equipment. Die casting, permanent mold casting, precision casting, etc. Refractories, control equipment and accessories for melting furnaces.

Precision Cast High-Speed Cutters

Condensed from "Machinery"

The Ford Motor Co. first used precision casting for turbo-supercharger buckets, which is by far its widest application at present. When this project was terminated, the knowledge gained was put toward the casting of high-speed steel cutters. The work on these cutters has been highly successful, as evidenced by the fact that 10,000 cutters have been produced in the Ford Laboratory. The cutters require no finishing, with the exception of a sharpening operation on the cutting edges.

Under the supervision of the Ford Trade School, rehabilitated veterans of World War II are producing cutters in a pilot plant at Dearborn.

The original or master pattern is carefully machined in steel or bronze, and from this pattern a babbitt mold or a plastic mold is formed. Similar molds are employed for making sprues, risers and runners. Wax held at constant temperature between 125 and 135 F. is injected into these dies under high pressure with a pneumatic ram. The wax employed is made up of a blue bulk wax and a resin, which is added to decrease shrinkage.

After the wax patterns are removed from the molds, they are mounted on suitable wax runners and wax risers are attached by use of a hot tool. This assembly is placed in a conical steel flask lined with asbestos paper and an investment mix is poured into the flask. Such materials as aluminum oxide, magnesium oxide and zirconia are used for investments, since it is felt that the high thermal expansion of silica is detrimental to its use.

The proportions of the chemically setting binder and refractory are carefully controlled. The invested flasks stand for 24 hr. and are then fired to temperatures ranging up to 1200 F. after wax removal at 150 to 160 F. The mold is hot when cast to increase flowability of the metal. The molds are cast under a gravity head. Temperature of the metal is controlled by use of an optical pyrometer.

Large castings are subjected to hardening and tempering operations that produce tough, fine grained structures. After pouring and shaking out the castings, gates and risers are removed by an abrasive saw, the parts are sandblasted, and after sharpening of cutting edges they are ready for use.

Considerable expense in the production of cutters has been eliminated by this process, and many more applications in the automotive industry are cited.

—C. O. Herb. *Machinery*, Vol. 51, Apr. 1945, pp. 144-151.

Slag Control

Condensed from "Iron and Steel"

Much progress has been made in recent years in improving slag control. An instance of improved control is a shop producing 500,000 tons of steel per year, which has secured 7.3% greater output, 0.3% greater yield from materials charged, and 10 cwt. less lime used per charge.

Common troubles are: Carbon sticking unexpectedly, bath getting too low in carbon owing to a sudden acceleration in the carbon drop towards the finish, sulphur sticking, and rephosphorization on making the finishing additions. To get the desired carbon, sulphur, phosphorus and manganese content and the correct degree of deoxidation and fluidity, it is necessary to get the right conditions in the slag.

Any lime added in excess of that required

The top charge feature of the Moore Rapid Lectromelt Furnace offers these advantages:

- >> INCREASED PRODUCTION OF QUALITY STEELS AND IRONS.
- >> QUICK CHARGE BY DROP BOTTOM BUCKET.
- >> CHARGING BUCKET CAN BE LOADING WHILE FURNACE IS MELTING PREVIOUS HEAT.
- >> LESS TIME LOSS BETWEEN HEATS.
- LARGE, BULKY SCRAP CAN BE USED.

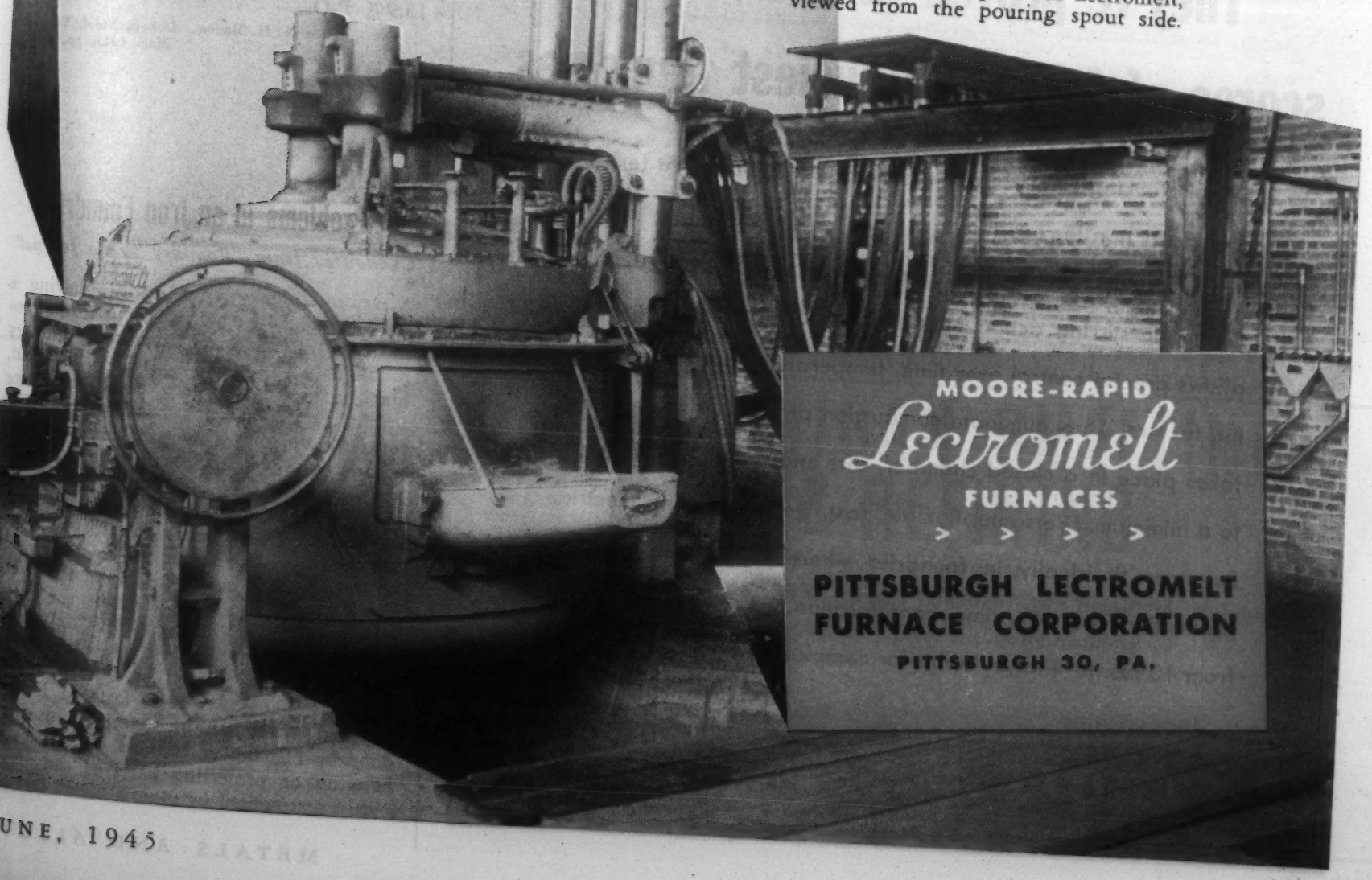
Top charging is practical and efficient because of Lectromelt's simplified design and construction, in which complicated operating mechanisms have been avoided. The large range of operations possible with Lectromelt is an important factor to consider. In addition, large or small heats may be made as desired or part of the heat may be taken out and the analysis of the remainder altered as required.

Lectromelt top-charge furnaces are available in sizes ranging from 100 tons down to 250 pounds. Write for complete information.

why *Lectromelt* top-charge *Increases Foundry Production*

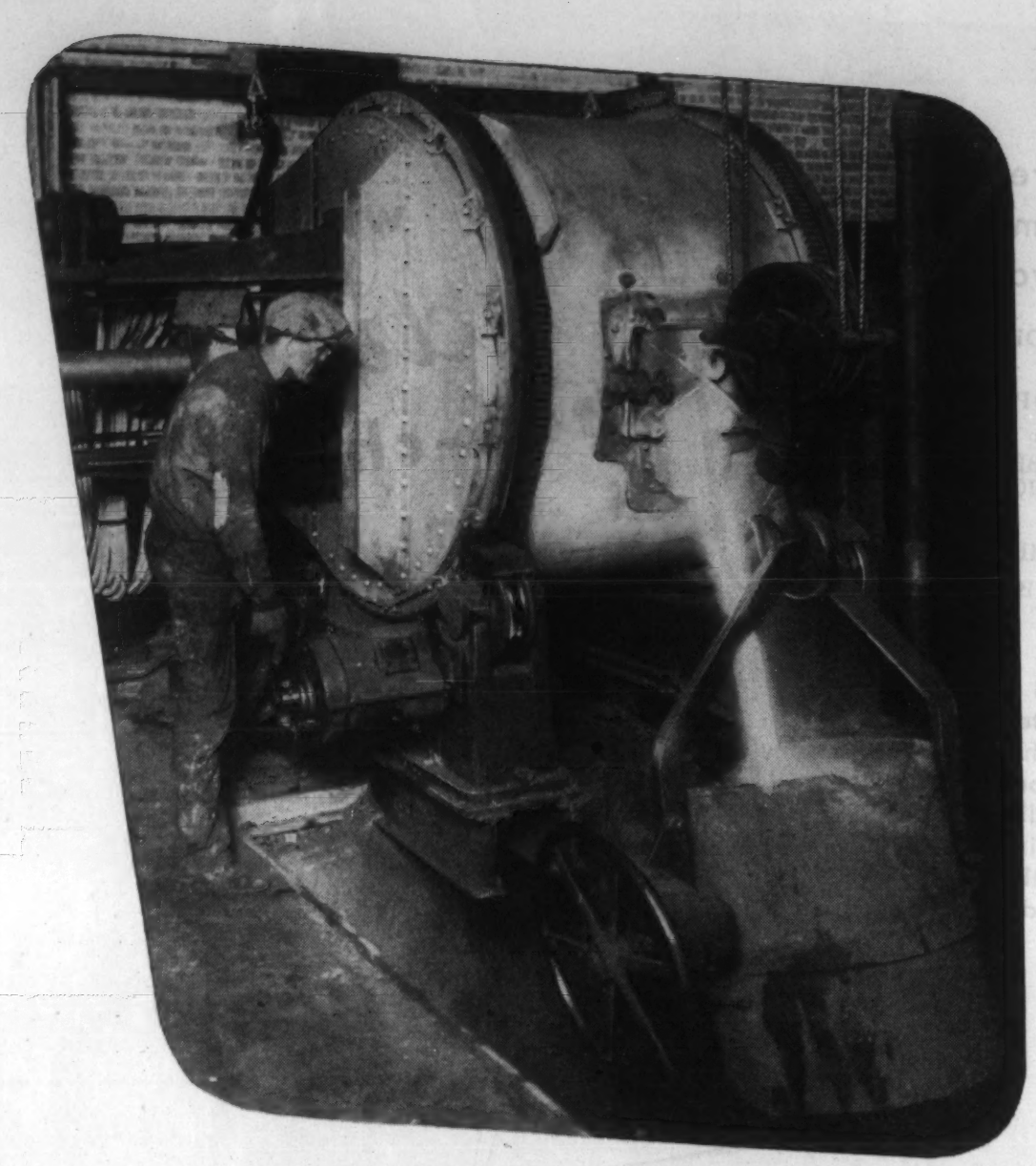
A.E.F. E NAVY

A size "PT", 3 ton-per-hour Lectromelt, viewed from the pouring spout side.



MOORE-RAPID
Lectromelt
FURNACES
> > > >

PITTSBURGH LECTROMELT FURNACE CORPORATION
PITTSBURGH 30, PA.



They've proven their worth in scores of America's busiest foundries

Detroit Rocking Electric Furnaces melt as many as eight ferrous or sixteen non-ferrous heats in one 8-hour day. They insure higher quality castings because their unique design permits automatic stirring action under non-oxidizing conditions and allows precise control over time, temperature, and other melting factors. They eliminate combustion products: since melting takes place in a closed chamber, dirt and fumes are reduced to a minimum. Versatile, flexible, fast, Detroit Rocking Electric Furnaces fit ideally in foundries where speed and quality production are of prime consideration. Available in sizes from 10 lbs. to 4 tons. Write for complete particulars.

DETROIT ELECTRIC FURNACE DIVISION
KUHLMAN ELECTRIC COMPANY • BAY CITY, MICHIGAN

to hold silicon, phosphorus and sulphur as stable compounds in the slag results in loss of lime, time and yield. The silicon and phosphorus contents of the burden can be taken as the most convenient means of determining the amount of lime needed. Experiments have shown that samples can be taken about 30 min. before the bath is clear melted, which gives proper time to calculate necessary feed lime and oxide additions.

Our experience reveals that silicon entering the charge from the pig iron and scrap is 2.0%. Considerable silicon enters from drippings from the furnace structure. Our examination showed that, using 80-ton fixed furnaces, the average weight from this source was 4 cwt. One must remember that the silicon which enters the charge is converted to silica by the time the bath has melted.

Determining the amount of lime, oxygen, etc. to add to the bath is all a matter of chemical arithmetic. As an example, if we calculate the total CaO from all sources, put in with the charge, we shall have a basis, sufficiently accurate. Say, we put in with the charge 4½ tons of lime and 1 ton of fluorspar, or the equivalent of 5 tons of lime.

The slag weight can be reckoned as double this lime weight, or 10 tons. We know the SiO_2 and P_2O_5 content to this slag by analysis. The weight of the P_2O_5 in the slag will increase as the result of the oxidation of the P in the metal, *i.e.* P_2O_5 in slag, 8.4%.

10 tons at 8.4% equals 0.84 tons of P_2O_5

P in metal 0.3%

80 tons at 0.3% equals 0.24 tons of P yielding 0.55 tons of P_2O_5.

The total weight of P_2O_5 in the burden will therefore be 0.84 plus 0.55 equals 1.39 tons, and this in 10 tons of slag gives us 13.9% P_2O_5.

—N. H. Bacon. *Iron & Steel*, Vol. 18, Mar. 1945, pp. 86-90.

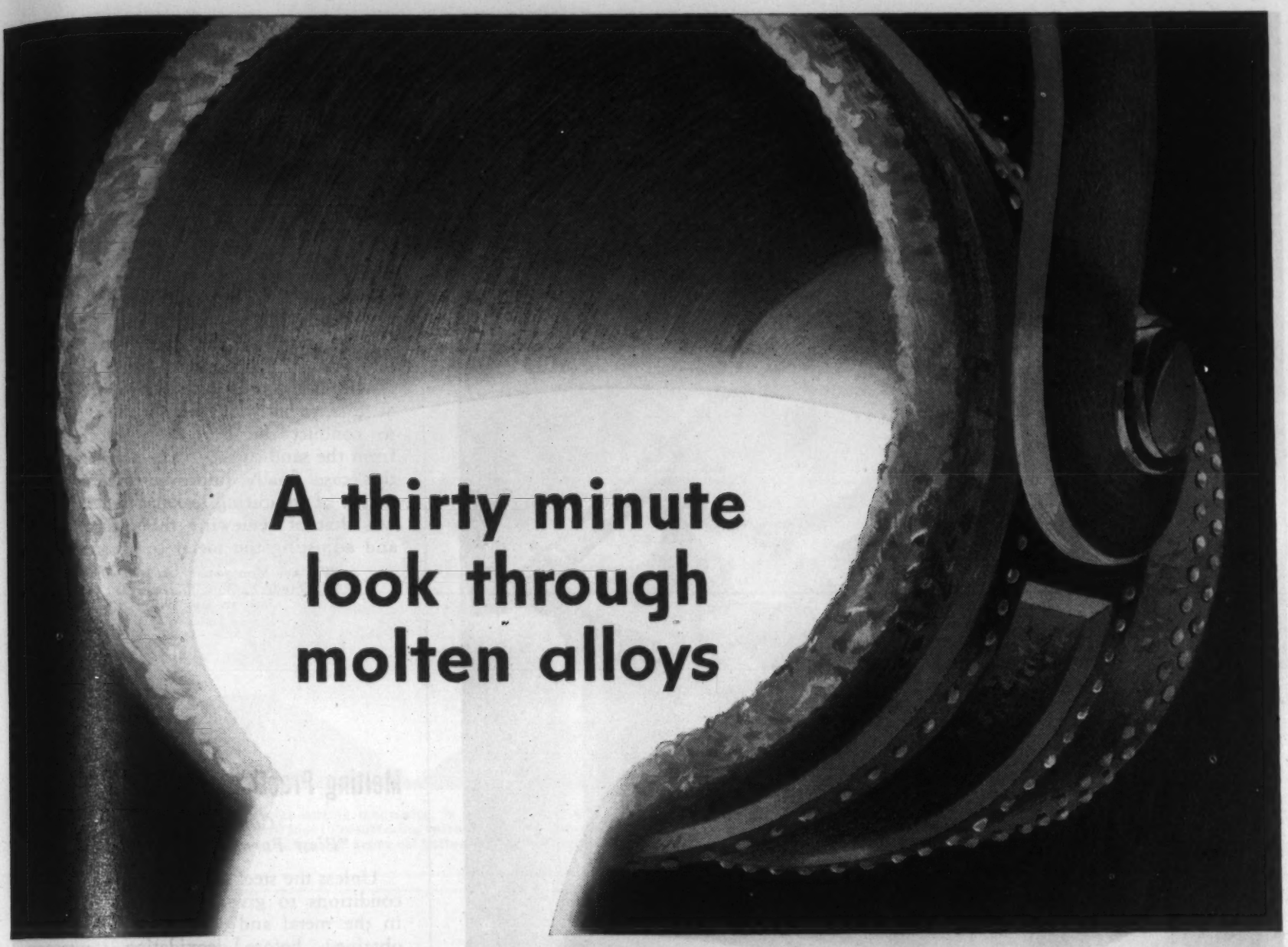
Problems in an Iron Foundry

Condensed from "Foundry Trade Journal"

A centrifugal pump casting, having a large flange joined by two webs to the center boss, offered some interesting foundry problems. The mold was in green sand, but the top flange and center boss were formed by an oil sand core assembly. The cores provided for a comparatively thin isolated and overhanging wedge of sand between the flange and boss.

The radiograph showed the location and the shrinkage defect at the base of the flange or seating, where no sudden change of section occurred. The seriousness of the defect lay in the fact that all the castings which showed radiographic indications of shrinkage leaked very badly at this spot.

This defect is caused by what is known in the literature as the "Leonard Effect," although many of the investigations were done by Fletcher and others. Briefly, overhanging or projecting parts of the mold, partly surrounded by molten metal, become



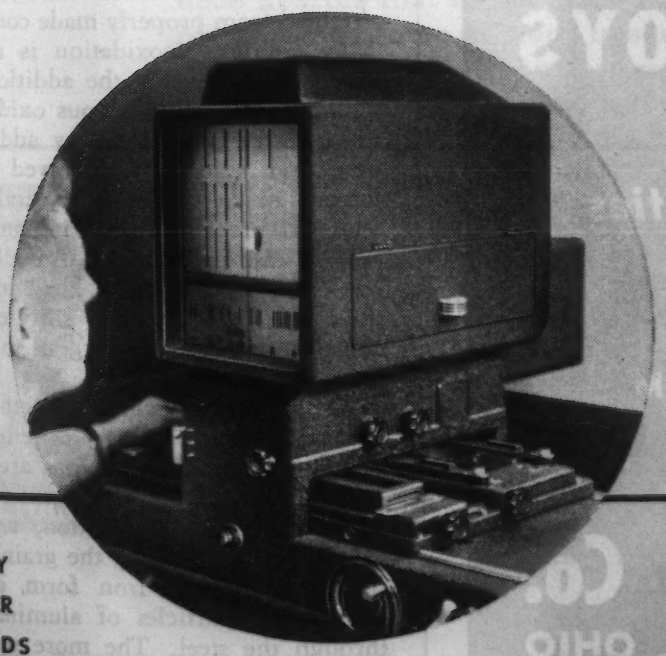
A thirty minute look through molten alloys

Every foundryman knows that molten brass should becast as soon as possible after it reaches the pouring temperature to assure good castings. The same is true of ingot.

But to give you ingot true to specification we must know accurately its composition while it is still in the furnace. This determination formerly took hours. Now it is done at Michigan Smelting & Refining in thirty minutes or less by using the Densitometer (shown below) in conjunction with the Spectrograph.

This rapid method of determining the presence of each element and in what quantity allows us immediately to do further refining to eliminate all injurious impurities and then make additions of alloying ingredients as required to bring the molten metal up to your specification.

This is your assurance that you get exactly what you order when you do business with this organization.



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MICHIGAN SMELTING & REFINING

Division of

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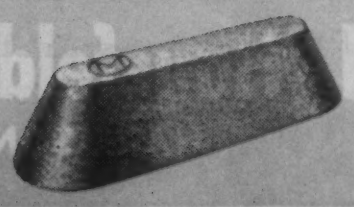
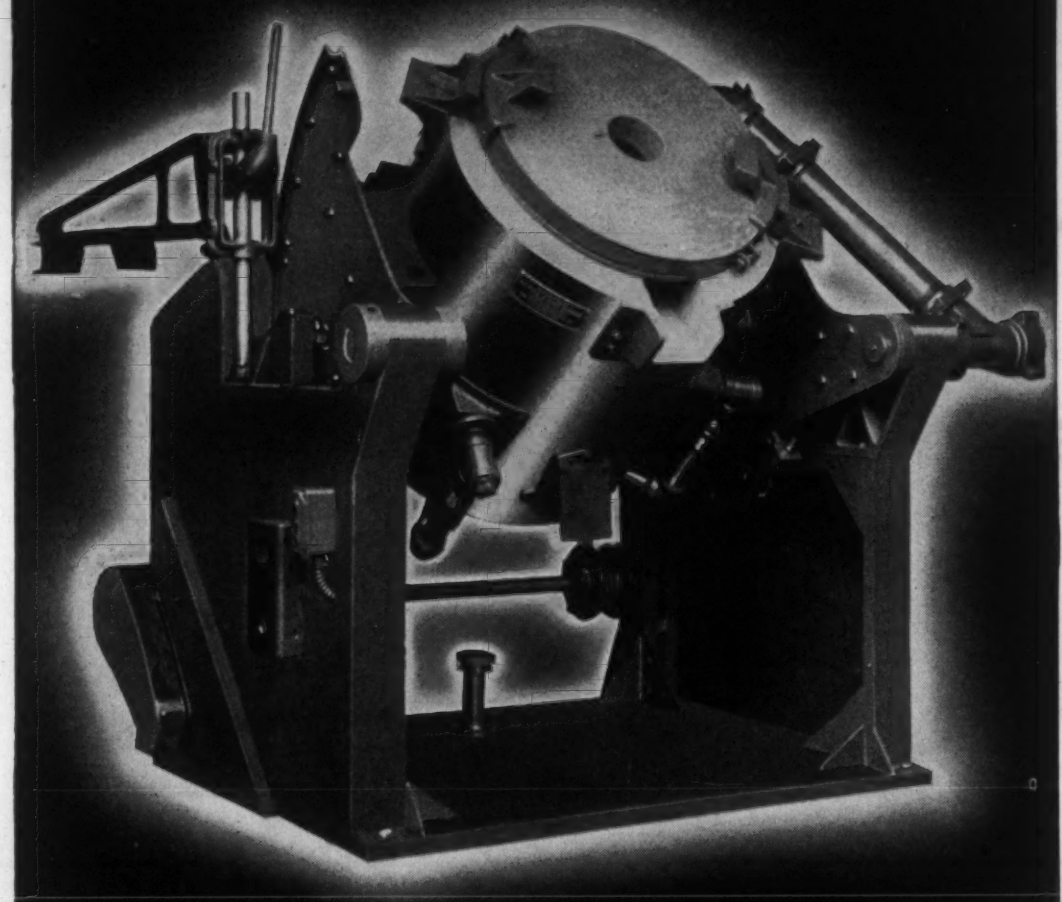
General Offices Lafayette Building



NON-FERROUS SCRAP METAL REFINERS FOR OVER 50 YEARS

HAUSFELD

NOSE-TILT **FURNACES**



THE EFFICIENT WAY TO MELT BRASS AND OTHER NON-FERROUS ALLOYS

Crucible Sizes from 225 to 400 . . . Iron and Steel Pot Capacities up to 2000 lbs.

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AND ALL OTHER
NON-FERROUS ALLOYS

The Campbell-Hausfeld Co.

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exceedingly hot, and in extreme cases the mold surface at that particular projection approaches the temperature of the molten iron. The resulting hot spot tends to hold the adjacent metal in a fluid pasty state after the neighboring parts have solidified, and naturally, cavities will be formed in this, the last part of the casting to solidify.

The cavity formed below a projecting wedge of sand which, to aggravate matters, lies in the path of the primary flow of metal in the mold. The metal may be poured at a lower temperature, but this is most unsafe, for the risk of trapping dirt and accluding gas is ever present with low-temperature pouring.

Another solution would be to chill or, at least, to sprig the sand at the critical part to conduct the heat away more quickly from the sand surface. The action, which in this case finally improved matters to the extent of inhibiting leakage under pressure, was that of reviewing the gating methods and adjusting the metal composition.

—William Montgomery & John Doig. *Foundry Trade J.*, Vol. 75, Jan. 11, 1945, pp. 25-29; Jan. 18, pp. 49-53; Jan. 25, pp. 71-74.

Melting Practice and Steel Properties

Condensed from "Blast Furnace and Steel Plant"

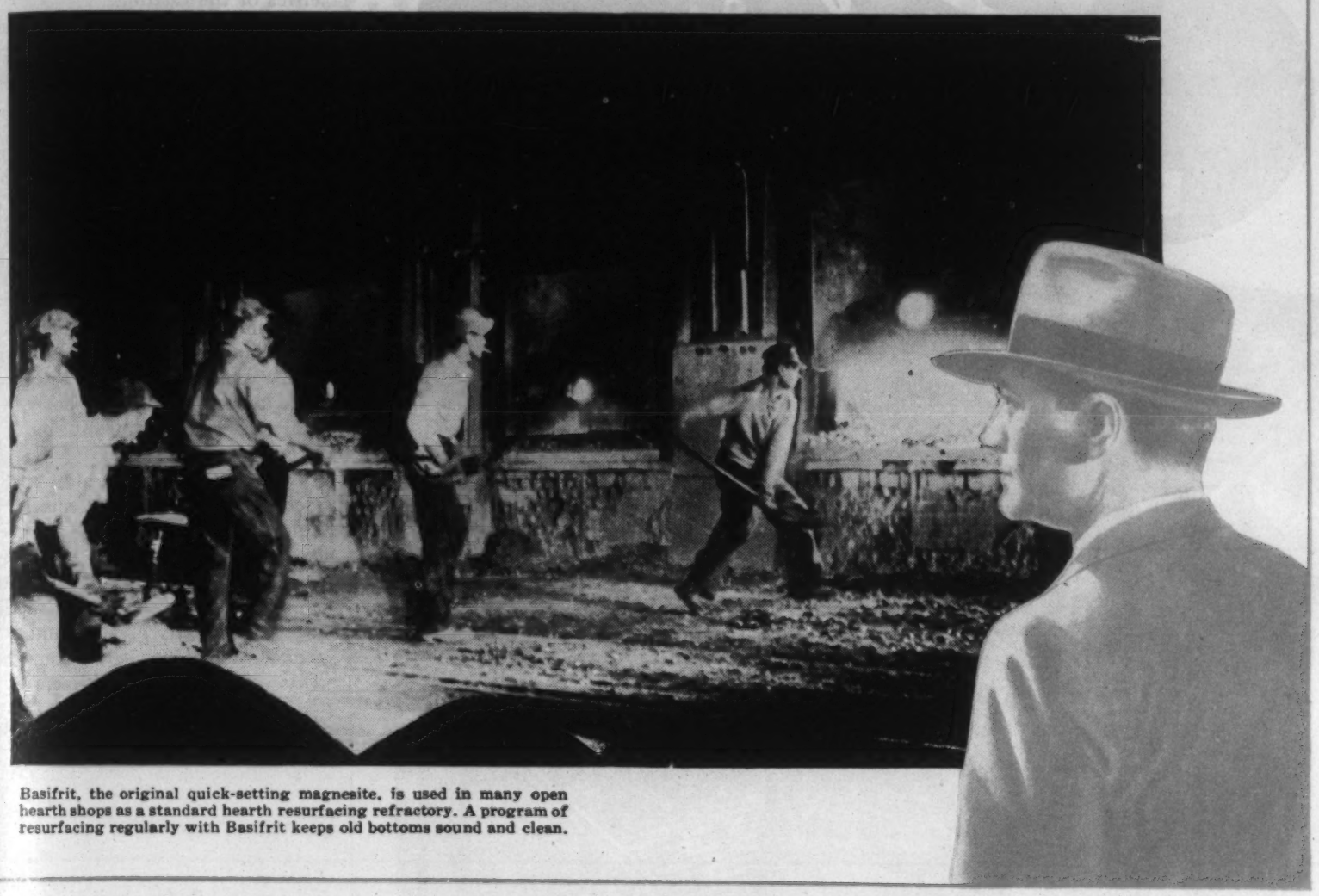
Unless the steel is melted under oxidizing conditions to give sufficient ferrous oxide in the metal and slag and a good boil is obtained, before deoxidation commences, clean steel, of fine grain and high impact resistance, cannot be made. The circulation of sufficient ferrous oxide through the bath and the presence of carbon monoxide evolved by oxidation of the iron carbide in a bath of steel sufficiently hot and fluid remove non-metallic inclusions and gases.

The charge should melt down to at least 0.4% C higher than required in the finished metal, in order to provide sufficient carbon for the carbon monoxide boil. The one process that invariably fulfills the requirements is the converter. This may well account for the excellent Izod impact values obtained from properly made converter steel.

In refining, deoxidation is achieved by slag reaction and by the addition of deoxidizing agents. The ferrous oxide, so useful in melting, is removed by adding manganese and silicon. If allowed to remain, ferrous oxide causes large grain size and tends to prevent the formation of a deep case in case carburizing. An alloy containing 60 Mn, 15% Si is ideal for cleansing the steel, as manganese silicate forms inclusions that are the largest and have the lowest melting-point.

The cleanest deoxidation method involves the use of a carbide slag in the basic electric furnace. No solid inclusions are formed.

Aluminum is the best agent for final deoxidation and degasification, and has the property of controlling the grain size of the steel. Crystals of iron form around the microscopic particles of alumina dispersed through the steel. The more particles, the more crystals are formed, and hence the finer the grain size.



Basifrit, the original quick-setting magnesite, is used in many open hearth shops as a standard hearth resurfacing refractory. A program of resurfacing regularly with Basifrit keeps old bottoms sound and clean.

FURNACE REFRACTORIES "DOCTOR"

DECREPIT old furnace bottoms, like sick old men, deserve expert attention.

Today there are hundreds of old open hearth furnace bottoms and electric furnace hearths that are operating on borrowed time. Some of them, in service for twenty-five or thirty years, or even more, are still hobbling along, doing praiseworthy duty in the prolonged program of war emergency steel production. It's no wonder they need careful nursing and expert doctoring.

That's why we call the Basic Engineer your Furnace Refractories "Doctor". This "Doctor" is trained in the most efficient refractory practice. He is a graduate of the school of experience — the actual making of basic open hearth and basic electric furnace steel. He is prepared to diagnose the ills of ailing old furnace bottoms and linings and prescribe first aid or more permanent treatments.

He can help you with major or emergency hearth repairs. He can help you set up resurfacing programs with Basifrit, where old bottoms are sound underneath, which will not only cut delay time, but protect or improve steel quality, too. Or he can help you establish improved fettling practice with Magnefer or Syndolag, or economical, time-saving sidewall maintenance programs with Gunmix.

Then later, when you can spare the time, the "Basic" Sales Engineer can help you plan a complete rehabilitation program—to install new hearths of Ramix in old furnaces you are rebuilding, so that for postwar you can make steel once more with least loss of time, least trouble, and at minimum refractory cost.

BASIC REFRACTORIES, INCORPORATED 845 HANNA BUILDING *Cleveland 15, Ohio*

Fisher PROVES IT AGAIN!

Experience-engineered equipment, plus a layout coordinated to the production requirements of your foundry provides the only answer to elimination of man-hour and material wastes. This modern war plant magnesium foundry, shown only in part, employs 2000 lb. Fisher Motorized Nose Pouring Furnaces in the background for melt down, and various sizes of Fisher Stationary Furnaces seen in the center, for superheating. The Stationary Furnaces can be used for both melting and superheating. Coordination of these furnaces with a monorail system eliminates arduous labor and minimizes time from furnaces to molds. Consulting with Fisher on your melting room layout and equipment problems will pave the way for better castings and more economical production.

Furnaces for melting all non-ferrous metals—write for literature.

Remember, if it's Monarch Equipment (or parts) —it's now made by Fisher, since our purchase of the furnace business of Monarch Engineering & Mfg. Co.

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Fisher FURNACE COMPANY

Engineers and Manufacturers

Nitrogen is of value in certain steels used for sand castings. It reduces the grain size of stainless and high-chromium heat-resisting steels, and improves the physical properties of the castings.

Hydrogen causes embrittlement. Sources of hydrogen in basic steel are hydrated lime used for slag making, wet alloying elements, and rusty steel scrap.

Possibly the great cause of poor steel is disregard of the time factor. Most operators like to skimp the boil, as it causes lining erosion and means a longer deoxidizing period. To speed up deoxidation and cut down time, excess silicon is used, resulting in a dirty steel with poor mechanical properties.

Refining under a slag demands time and temperature for the reactions to proceed. The experienced melter will never force a heat to meet a schedule, but will treat every heat as a separate metallurgical problem to be solved.

Alloy additions should be made when the metal is deoxidized and sufficiently hot and fluid. Alloying materials may be a source of gas, and a steel that has been degasified may be re-infected by these additions.

A trace of ferrous oxide facilitates pouring and imparts greater fluidity than over-reduced metal has at the same temperature. This calls for a nice judgment by the melter.

—J. A. Preston. *Blast Furnace & Steel Plant*, Vol. 33, Mar. 1945, pp. 366-368, 383.

Refractories for Copper Reverberatories

Condensed from "Journal of the American Ceramic Society"

Metallurgists have suggested the desirability of higher temperatures in the hot zone of the reverberatory copper furnace, and have pointed out the need for better refractories before temperatures can be increased much more. A series of tests was conducted to study the reaction of slags with various types of refractories.

Samples of refractory bricks were heated to 1300 C. (2370 F.) and held at this temperature for six hr. in contact with slag samples. Another set of refractories was heated to 1400 C. (2550 F.) and held for 24 hr. in contact with the slag. Diffusion of the slag into the refractory was then determined.

For silica brick, it was found that porosity of the refractory played an important part in the slag diffusion. Despite its acidic character, the brick showed deep penetration, particularly at the higher temperature.

Fire-clay brick showed little penetration at the lower temperature, and it was deemed satisfactory for use at that temperature. However, increase of temperature had a marked effect upon this refractory. There was corrosion of the surface and some penetration of the brick. The sharp decrease of resistance seems to indicate that the fire-clay brick would not be satisfactory at higher temperatures.

High-alumina bricks, which are both basic in reaction and porous in structure, are attacked more readily than the ordinary

Cleaner Steel With

SIL·X

REGISTERED TRADEMARK
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EXOTHERMIC FERROSILICON

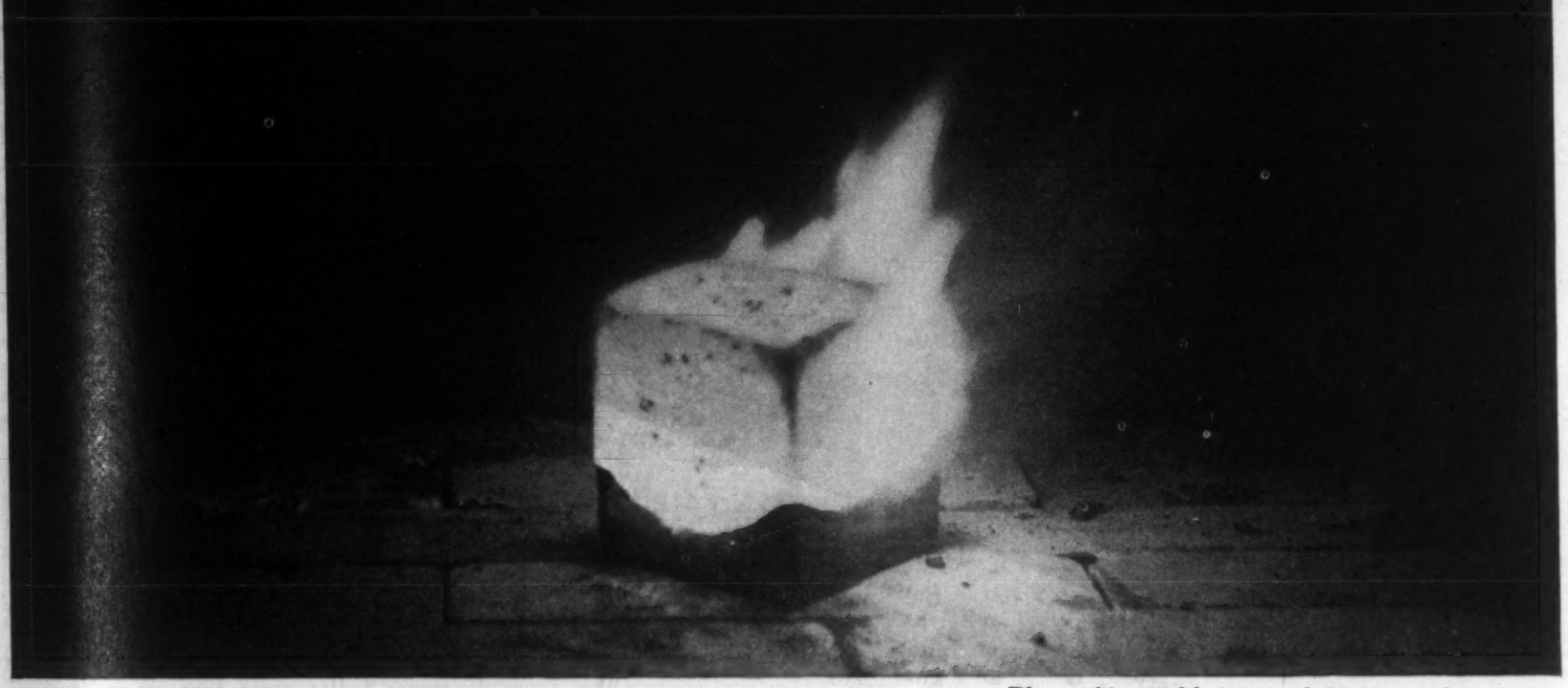

Photo of ignited briquet exhibiting exothermicity.

"SIL-X" is widely used by operators of

OPEN HEARTH FURNACES
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Its exothermicity provides molten ferrosilicon at the desired spot, whether in the furnace or ladle. The use of "SIL-X" results in cleaner metal with lower conditioning costs.

Prepared in two grades—"75" and "145". Write for information on the use of "Sil-X", "Chrom-X" and "Riser-X".

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EXOTHERMIC FERROCHROMIUM

For furnace or ladle additions, giving higher recoveries and rapid uniform distribution of chromium in steel or iron.

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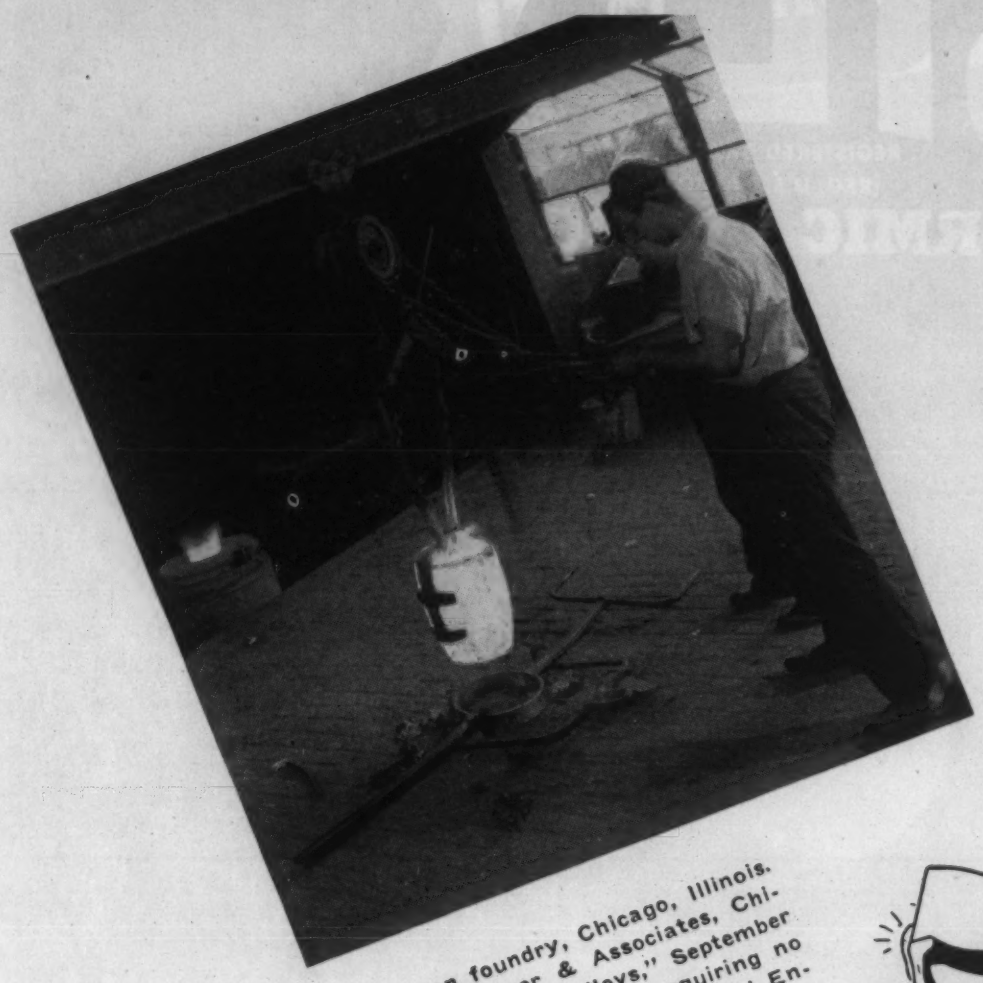
Special Aluminum Alloy Melted in Crucibles



Oscar W. Hedstrom Corporation foundry, Chicago, Illinois. Photograph courtesy Howard G. Mayer & Associates, Chicago, Illinois. For data see "Metals and Alloys," September 1944, page 643, "Strong Cast Aluminum Alloy—requiring no heat treatment," by Albert J. Matter, Chief Mechanical Engineer, Oscar W. Hedstrom Corporation.

In quantity production or special alloys, crucible melted metal meets the specifications. Crucible melting allows close metallurgical control, extreme flexibility in output, and is the most practical economical method.

For melting small heats or large, use crucibles for the best profits. Crucible furnaces are the most adaptable for production, jobbing or special purpose alloys.

Crucible Melters Handbook gives profitable information on the care of your crucibles.

Typical Crucible Furnace Installation No. 4

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and super-duty firebrick. Their general reaction scheme was similar to that of the fire-clay brick.

Magnesite brick seem to be suitable for use with the acid copper slag. They are suggested as a desirable structure, as the bricks show good resistance to slag corrosion, low porosity, and little tendency to spalling.

Forsterite brick, next to the silica brick, shows the deepest diffusion of slag into the brick. There is also appreciable corrosion of the contact surface. Because of its short life, this refractory is not to be suggested for use with the acid copper slags.

Chrome and chrome-magnesite bricks were also found to be suitable. While there appears to be some diffusion of slag into the chrome brick, there was no visible corrosion. A close-packed mixture of coarse chrome grains and finely ground magnesite was suggested as offering the possibility of good slag resistance, low porosity, and little tendency to spalling.

Water-cooled jackets, it was concluded, would increase the life of the furnace walls.

—Sahap S. Kocatopcu. *J. Am. Ceramic Soc.*, Vol. 28, Mar. 1945, pp. 65-71.

Uses of Gases in the Foundry

Condensed from "Foundry Trade Journal"

Gas has been available for foundry work for a number of years, but full advantage has not been taken of it on account of cost. This is thought to be the drawback but when examined in its widest aspect, gas is not expensive in the long run, while satisfactory and reliable results are obtained.

Gas is clean and simple to apply to molds, stoves, ladles, cores, furnaces and numerous other jobs where drying or heating are concerned. A plant worthy of consideration in the modern foundry is the gas producer. It consists of a gas generator scrubber, gas purifier, exhauster and pressure regulator.

Much of the labor, trouble and smoke nuisance of kindling cupolas operation can be avoided by the employment of gas torches. Two kindling tuyeres are provided on opposite sides of the furnace, about 6 in. from the bottom and fitted with external collars fixed to the furnace shell. The collars are connected to the gas and air supplies and are tapered internally to receive the removable burner assemblies, so that gas and air passages in the two parts mate when the burner is inserted in the collar.

The burner consists of a body casting having gas and air passages leading to two concentric steel tubes into the body, the air being led to the outer tube and gas to the inner.

The operation is simple, and in about 10 min. after lighting the gas and adjusting the air supply, the coke is burning sufficiently well to permit the gas to be turned off. The air is left on for a further period to assist the burning up of the bed.

A further convenience of having gas at the cupola is for drying the tapping hole and spout. Drying a large baseplate, drying machine-made molds, etc. are other uses for gas heating in the foundry.

—Harold Haynes. *Foundry Trade J.*, Vol. 75, Mar. 15, 1945, pp. 209-213.

A FEW FACTS ABOUT CORHART PRODUCTS

Corhart Electrocast Refractories are high-duty products manufactured by melting selected and controlled refractory batches in electric furnaces, and casting the molten material into molds. After careful annealing, the finished shapes are ready for shipment. Dense, high-melting refractories, they are especially designed for resistance to corrosive action.

PRODUCTS

CORHART STANDARD ELECTROCAST is a high-aluminous refractory.

CORHART ZED ELECTROCAST is Zirconia-bearing.

CORHART ELECTROPLAST is a high-temperature plastic refractory made from Standard Electrocast which has been ground and crushed. Especially designed for ramming. Furnished dry.

CORHART MORTAR is a high-quality cement for laying up Electrocast, clay brick, or any aluminous refractory.

CHARACTERISTICS OF STANDARD ELECTROCAST

POROSITY: Less than 0.5%—therefore virtually no absorption.

FUSION POINT: Cone 38 without any appreciable softening below that point.

HARDNESS: 8, Mineralogist's scale.

SPECIFIC GRAVITY: Blocks weigh approximately 183 lbs. per cu. ft.

COEFFICIENT OF EXPANSION: 0.000006 between room temperature and 900° C.

SPECIFIC HEAT: 0.25 cal. per gm. per °C. at 980° C.

THERMAL CONDUCTIVITY: 25 BTU per sq. ft. per hour for gradient of 1°F. per inch.

COMPOSITION: Standard Electrocast is of an aluminous crystalline nature.

CORROSION: Because of low porosity and inherent chemical make-up, Corhart products are highly resistant to corrosive action.

APPLICATIONS

Most heat processes present spots where a better refractory material is needed in order to provide a balanced unit and reduce the expense of repeated repairs. It is for such places of severe service that we invite inquiries regarding Corhart Products as the fortifying agents to provide the refractory "balance" desired.

The following is a partial list of applications for which Corhart Products are suggested:

ELECTROLYTIC CELLS — for production of Magnesium and other light metals.

SILICATE OF SODA FURNACES — sidewalls, bottoms, and breastwalls.

HEARTHS AND SMELTERS — for non-ferrous metals.

ALKALI AND BORAX MELTING FURNACES — fast-eroding portions.

GLASS FURNACES — the entire installation of flux walls and bottoms, breastwalls, ports, tuck-stones, forehearths, recuperators, etc.

RECUPERATORS—tile, headers, separators, etc.

ENAMEL FRIT FURNACES — flux walls and bottom.

BRASS FURNACES — metal contact lining.

ELECTRIC FURNACES — linings for rocking type, and rammed linings of Electroplast for this and other types.

BOILERS — clinker line.

STOCK SHAPES AND SPECIALS

Standard and Zed Electrocast are made in stock shapes and in many special shapes. The weight of individual pieces may run to 3500 pounds.

IF YOU NEED A BETTER REFRACTORY—

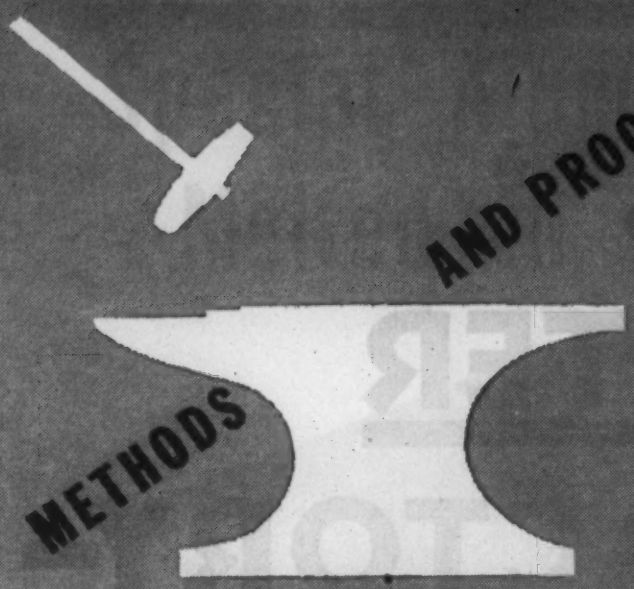
● Corhart Electrocast Refractories are high-duty products which have proved considerably more effective than conventional refractories in certain severe services. If your processes contain spots where a better refractory is needed to provide a balanced unit and to reduce frequent repairs, Corhart Electrocast Refractories may possibly be the answer. The brief outline at the left gives some of the basic facts about our products. Further information will be gladly sent you on request.

Corhart Refractories Company, *Incorporated,* Sixteenth and Lee Streets, Louisville 10, Kentucky.

"Corhart" is a trade-mark, registered U. S. Patent Office.

QUALITY ECONOMY ENDURANCE

CORHART ELECTROCAST REFRACTORIES



FABRICATION and TREATMENT

Machining, forging, forming, heat treating and heating, welding and joining, cleaning and finishing of solid materials. Methods, equipment, auxiliaries and control instruments for processing metals and nonmetals and for product fabrication.

Organic Finishes for Magnesium

Condensed from "Light Metal Age"

In all organic finish systems for magnesium, the primer coat will be the first material applied. Both mandatory and desirable qualities for a magnesium primer have been well established. The mandatory qualities are those that affect adhesion and protection, the desirable add not only to the above but aid in manufacturing and processing.

The mandatory includes: Resistance to salt water and moisture penetration; good adhesion to the metal or oxide film; provide bonding surface for subsequent coats; flexibility and toughness; and inhibit corrosion. The desirable include: Rapid drying; subsequent coats must not affect the primer-metal bond; imperviousness to actinic rays; insoluble in gasoline or other hydrocarbons when dry; may be removed without harming the base metal (when refinishing).

In general, basic pigments have proved most satisfactory, and zinc chromate exhibits the best all-around characteristics. Use of red oxide has met with good results, but requires baking to exhibit optimum qualities.

As to a vehicle or binder for the pigment, selection may be modified to meet manufacturing or service demands; oxidizing oils, such as linseed oil, will give good service as a primer vehicle. Linseed oil, however, in either the boiled or raw form, is exceedingly slow to dry—a disadvantage from the manufacturing standpoint. Also, oxidizing oils remain somewhat soft and lack abrasion resistance.

The alkyd resins, though lacking immersion resistance, are quite resistant to atmospheric moisture penetration. The nitrocellulose lacquers, as a primer vehicle, are fast drying, but tend toward brittleness with a resultant loss in adhesion. The large number of synthetic resins available, along with hard resins and various plasticizers, offers wide possibility in blending a primer vehicle to meet practically any contingency.

For exterior exposures free from industrial or saline contamination, the oil-base synthetic resin enamels of the glycerol phthalate types will give satisfactory results. Another material that provides good protection under ordinary atmospheric conditions is a good spar varnish pigmented with aluminum paste in the ratio of 2 lb. of paste per gal. of vehicle.

Under severely corrosive exterior conditions, it is best to adhere closely to the use of products meeting various military and service specifications. Zinc chromate meeting Army Specification 14080 and enamel meeting Navy Specification M67 are two products widely employed. More recent investigations and compilations of service data indicate that baked finishes are very effective for the protection of magnesium, but here the effect of baking temperatures on the properties must be considered.

The number of prime and finish coats required will depend upon conditions to be encountered. One coat of primer supplemented by one or two coats of finish is generally employed when the product will be exposed indoors. At least two coats of recommended finish should be applied for normal outdoor exposure.

Under extremely corrosive conditions, opinions differ as to the actual number of prime and finish coats to employ. One coat of primer and at least three coats of finish are required for best results. Certain data indicate the advisability of using multiple coats of primer.

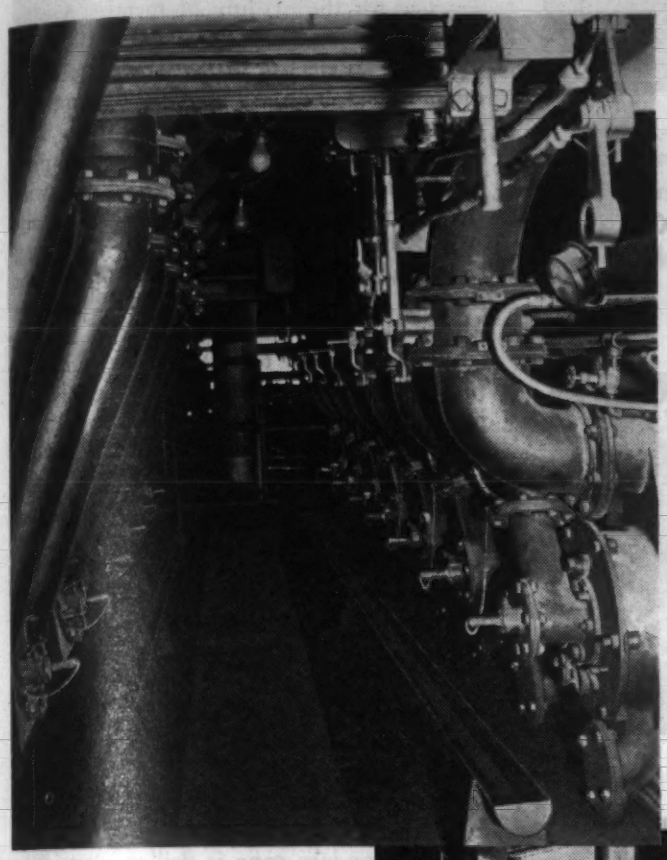
—G. C. Close. *Light Metal Age*, Vol. 2, Nov. 1944, pp. 20-22.

Diamond Dies

Condensed from "Steel"

The manufacture of many essential electronic products is dependent on superfine wires drawn through small diamond dies, which formerly were available only in

SIMPLIFIED FIRING FOR METALLURGICAL FURNACES . . .



SAVES FUEL AND SPACE INCREASES PRODUCTION

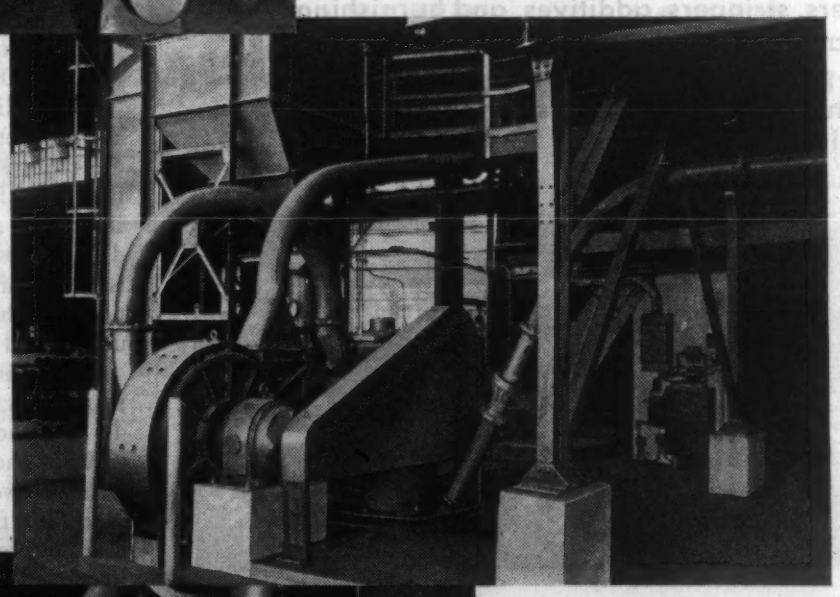
Dependable and economical pulverized-coal firing of multiple metallurgical furnaces requires only ONE pulverizing unit with the B&W Direct-Firing Circulating System. Thus, many substantial savings on installation, production, and maintenance over other methods of firing are obtained.

Simplicity of the system eliminates multiple piping and coal handling equipment, saves floor space around the furnaces, and eliminates interference with product handling at the furnaces.

Adequate fuel distribution and capacity of this system on single or multiple furnaces is assured by automatic control of coal-to-air ratio, by selection of the proper sizes of pulverizers, fan, burners, and distributing line.

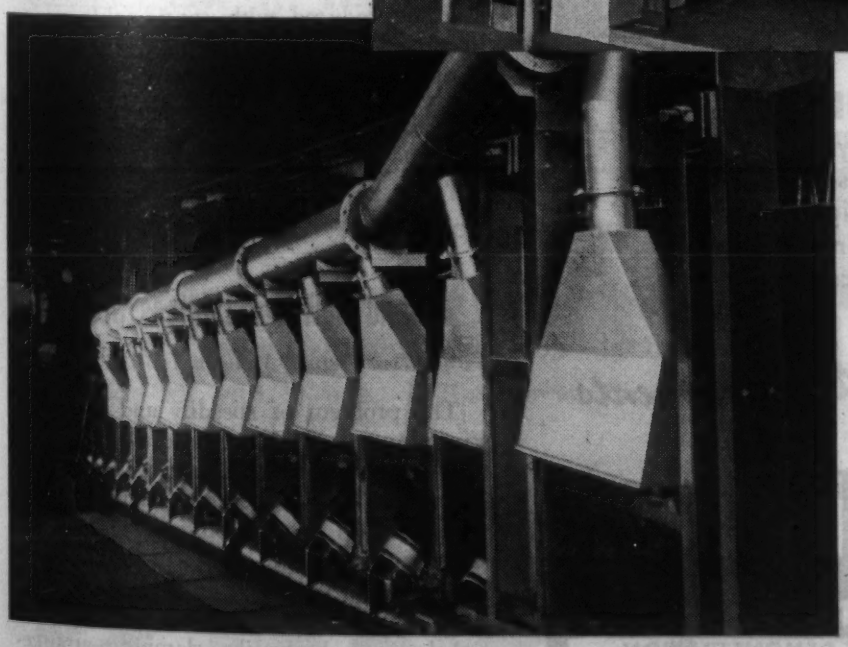
The operating ease and flexibility of this system, as well as its cost-saving features, have been clearly demonstrated by the performance of existing installations.

A few of the advantages of the B&W Direct-Firing Circulating System are illustrated here. More detailed information is contained in Bulletin 3-333. Send for your copy.



1 Multiple burner installation on single large furnace of double heating zone type. Burners at right firing heating zone and first group of burners in the circuit. Burners at left fire soaking zone and last group in the same circuit, which also serves a second large furnace of the double heating zone type.

2 The single, compact pulverizer unit can be conveniently located away from the furnaces, keeping floor space at furnaces clear for product-handling operations.



3 Hoods and ash sluicing systems eliminate dust nuisance ordinarily resulting from firing pulverized coal in heating furnaces with inadequate draft provision.

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THE BABCOCK & WILCOX CO.
85 LIBERTY STREET
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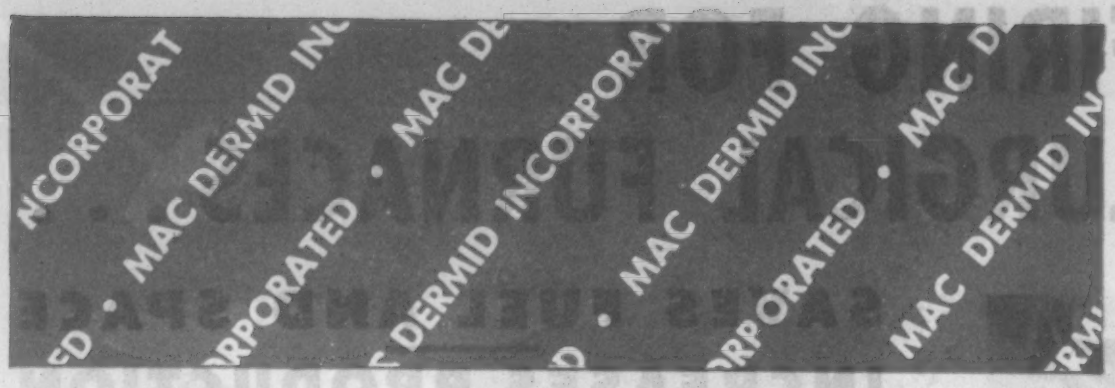

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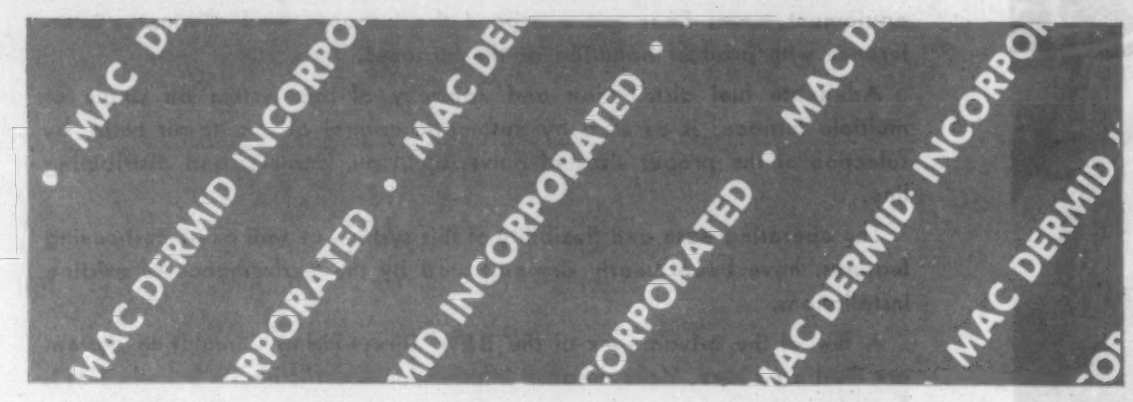

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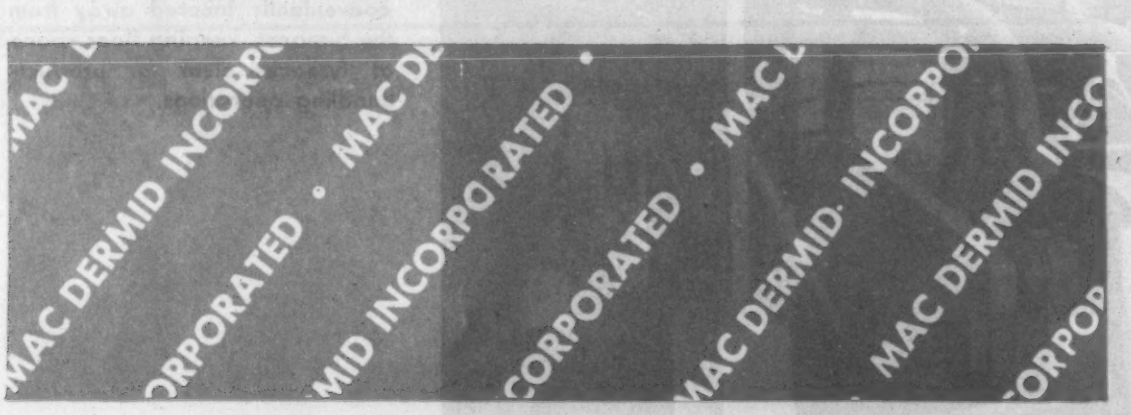

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Europe. A new electrolytic method of diamond drilling employs an electric spark shot from the end of a platinum needle at the diamond while both are immersed in a chemical solution.

The diamond die drilling methods developed at the Bureau of Standards parallel established machine and instrument shop practice for the drilling of metals. A pilot hole is fore-drilled through the diamond by means of an electric spark. To complete the operation, a light commercial drilling machine is the only equipment required.

The point of the drill follows the pilot hole without being dulled by contact with the diamond. The conical surface of the drill, which has considerable peripheral speed, acts as a countersink or reamer for shaping the contour of the cones and applying the polish to the cone and bearing surfaces. Thus, the tedious and time-consuming star drilling operation, which is the basis of previous methods, is eliminated.

With the electric die drilling method developed at the National Bureau of Standards, two parallel facets and a window perpendicular to these are cut on the diamond with a cast iron lap. The operation requires about 2 hr. per blank, and at least two can be run simultaneously.

To form the bell cone, a pilot hole is fore-drilled electrically, followed by countersinking on a drilling machine. This operation repeated until the desired depth is attained requires about 3 hr. per die. One operator can care for two electric drills or 10 countersinking spindles.

The secondary cone is drilled electrically in 1 hr. One operator can run two units.

The polishing operation is performed on a light rotary drilling machine, and each die requires approximately 30 hr. to obtain the best finish. One operator, however, should be able to care for at least 30 spindles because application of a new abrasive is required only 2 or 3 times during the period. The machine can be allowed to run unattended during the night.

Total time for flat opened-type is 4.0 man-hours; for sphere opened-type it is 4.5 man-hours.

With the method required in this report, it is believed that a good quality fine diamond die from 0.0004 to 0.0015 in. in size can be produced with considerable saving in time and cost over the established mechanical methods.

—*Steel*, Vol. 116, Mar. 19, 1945, pp. 122, 124, 127, 166.

Band Sawing Stainless Steel

Condensed from "Modern Industrial Press"

The problem of speedily and accurately trimming a tough, triple-drawn, double-walled, 16-gage stainless steel ball joint and its interlocking socket and clamp was superbly solved by a revolutionary motorized saw fixture designed and built at Lockheed Aircraft Corp.'s plant A-2 for a Yates-American 30-in. wheel band saw. Gripped tightly in a brake-like clamping arrangement, the one-piece reverse-drawn ball joint is trimmed completely in approximately 40 sec.

How much metal are *YOU* depositing in *YOUR* welds?

For better results in welding steel... choose the *RIGHT* electrode!

• That's the only sure way to get better results—lower costs. Give it some thought!

Important factors in improving your electrode efficiency are: (1) slag control during welding, (2) minimum arc blow, (3) easy striking of arc, and (4) elimination of crater cracking. But don't stop there. Consider also such points as good penetration, burn-off rate, smooth bead appearance, good X-ray properties, and rate of deposition in pounds per hour.

The electrode that gives you the best balance of these qualities—on your specific job—is the *right* electrode for you to use. If it's for welding steels, you'll find it among the P&H Electrodes shown above. Let your nearest P&H representative help you select it. Or write us.

P&H also manufactures a full line of electrodes for welding stainless and alloy steels, as well as for hard surfacing. Ask for literature.

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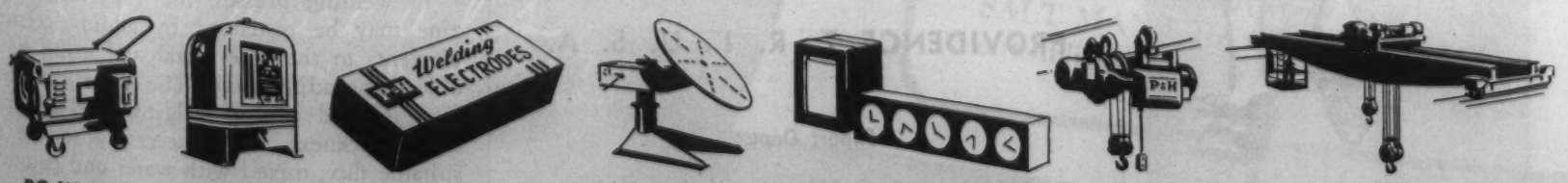

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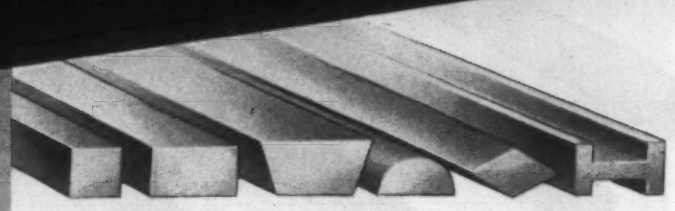

The metal trade's established method of drawing rod to triangular, rectangular and special shapes such as keystone, diamond, star and channel forms—both plain and ornamental. "Standard" Turks Heads, universal and plain types, are available in a wide range of capacities.

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After the part has been securely fastened in the steel nest and the wear plate has been lined up with the saw blade, the fixture is ready for operation. The operator feeds the stationary outer wall of the ball into the blade at constant pressure. In just a few seconds the blade has entered the stainless steel (Type 347) almost ⅜ in.

The steel is now red hot in localized area. The fixture revolves clockwise in 2½ r.p.m. into the swiftly downward moving blade. This sturdy, high-speed blade "burns" its way through the hard 0.062-in. metal until one revolution is completed and the rejected band topples off clear of moving parts.

The operator follows up by quickly indexing the carriage into the blade to repeat the operation for cutting the inner. As the course is terminated and the plate is discarded, the assembly is swung away from the running saw blade. The completely trimmed joint is released and the nest rapidly reloaded.

Due to its configuration, trimming this part on the lathe requires two set-ups instead of the one sufficient on the saw. The lathe produces a part in 10 min., compared to 40 sec. on the band saw. The ball joint represents an extremely high production job that is easy on the operator.

—Jack L. McGraw & Aaron H. Shum. *Modern Ind. Press*, Vol. 7, Feb. 1945, pp. 27-28.

Fusion Welding Copper Alloys

Condensed from "The Welding Journal"

More heat is required for welding copper than steel and a larger size tip is used. The welding rod is completely deoxidized and, in general, flux is not needed. Parts are usually tack-welded before welding. If not, a greater spread at the finishing end of long seams must be allowed than with steel. Standard jigging principles apply, but there is no need to use chill plates.

Actual welding technique for copper is much the same as with steel. The base metal should be melted before the welding-rod is allowed to flow on it. When possible, the weld should be completed in one pass.

After welding, it is good practice to peen or hammer the weld to reduce grain size and locked-up stresses. Material thicker than 0.22 (14 gage) should be peened hot and thinner material cold worked. Cold-peening will raise the tensile strength but reduce ductility, which may then be restored by heating to a red heat.

In bronze-welding copper, the regular rod and technique are used. Bronze-welding cannot be used when an exact color match is necessary, nor in certain chemical applications. It can be used for electrolytic copper but is more frequently used on deoxidized.

In welding brasses, the vaporization of zinc may be restricted by adding certain elements to the base metal and using suitable flame adjustment. The same joint design is used as for welding steel of the same thickness. It is necessary to use a suitable flux, mixed with water and painted on the rod and the base metal. The best

Another tough cleaning problem solved by "THE PENN SALT MAN!"

THE aircraft industry has offered some of the toughest metal cleaning and plating problems in war production plants. It has been our privilege to be helpful through our products and our men in the solution of many such problems. Both the men and the products of Penn Salt's Special Chemicals Division are prepared not only for these war-time services but are equally well prepared for reconversion and the problems of the future.

Here is an actual case of a leading aircraft engine manufacturer, drawn from our files:

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PRODUCTS USED: PENNSALT CLEANERS EC-10, No. 37, and K-7 BEFORE LEAD PLATING WITH PENNSALT LF-42

PROBLEM: To remove slushing oil from copper-lead alloy and silver plated steel bearings prior to lead plating.

EQUIPMENT: Plating done in individual pyrex glass plating tanks, large enough to accommodate one bearing. Conventional soak and electrolytic cleaning tanks.

OUR METHOD:
1. Preclean with Pennsalt EC-10 (solvent dip) followed by spray water rinse.
2. Soak clean in Pennsalt #37, 6 oz/gal., 5 to 10 minutes, 190 to 200° F.
3. Hot water rinse.
4. Electroclean in Pennsalt K-7, 8 oz/gal., 190° F., 15 to 30 seconds—work made the cathode.
5. Hot water rinse.
6. Lead plating solution made up of one part Pennsalt LF-42 to two and one-half parts water —with glue addition. Used at room temperature, 15 amps./sq. ft., for 28 minutes, which plates .001" thickness.
7. Cold water rinse.
8. Cyanide dip.
9. Indium plate.

COMMENTS: This cycle employs four Pennsalt Products.

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Many of these installations, which were made primarily because they offered the advantage of saving the cost of cooling water, now show an extra value of great importance in increasing plant production.

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results are usually obtained by using forehand welding. When openings are required, as in brass piping installations, iron cement is painted around the openings, and metal to be cut out is heated to red heat, and the oxidizing flame is used to melt out the opening.

Welding done on bronzes is usually for repair work. If color match is desired, the rod must be similar in composition to the base metal. A flux should be used. In welding bronzes containing high amounts of tin, lead or phosphorus, the use of a strongly excess-oxygen flame will eliminate the melting out of these constituents. A correct flame adjustment is necessary.

Copper-silicon alloys are weldable, have a lower heat conductivity than copper, and are not so sensitive to overheating as other copper alloys. The joint design used is similar to that for steel. Thicknesses up to 3/8 in. should be welded in one pass. A welding rod of a composition similar to that of the base metal is preferable. A concentrated flame in a small welding puddle is best.

Generally, the base metal should not be clamped tightly in jigs. These alloys should be welded as rapidly as possible. In general, no after treatment is required. Mechanical properties can be improved by hot hammering. The grain structure can be improved, but probably not the ductility, by cold-peening followed by complete or local annealing.

—H. R. Morrison. *Welding J.*, Vol. 24, Mar. 1945, pp. 225-230.

Electroforming Techniques

Condensed from "Proceedings of the American Electroplaters' Society"

Methods for electroforming band instruments, as done at C. G. Conn, Ltd., produce cornet and trumpet bells, trombone bells and slides, 90° and 180° tubular crooks, valve assemblies, etc. The most difficult development was the electroforming of kettle drums.

Techniques for electroforming have been worked out for copper, nickel, silver, iron, brass and nickel-cobalt alloys. Detailed discussion is limited to acid copper.

The solution used contains 235 g. per l. (32 oz. per gal.) copper sulphate, 75 g. per l. (10 oz. per gal.) sulphuric acid, and 1 part in 800 by volume of molasses. A current density of 3.5 to 10 amp. per sq. dm. (35 to 100 amp. per sq. ft.) is used. Continuous filtration of the plating solution through activated carbon or clay is necessary in order to prevent deposit roughness.

Molasses, a grain-refining addition agent, is the most satisfactory addition agent tried under continuous filtration conditions because of its wide concentration tolerance. For most applications, insoluble anodes are required. A 1% silver-lead alloy has a longer life than any other insoluble anode tried.

A parting medium containing airspun graphite, 300 to 400 g. (3 to 4 lb.); beeswax, 100 g. (1 lb.); rosin, 25 g. (¼ lb.); trichlorethylene (or carbon tetrachloride),

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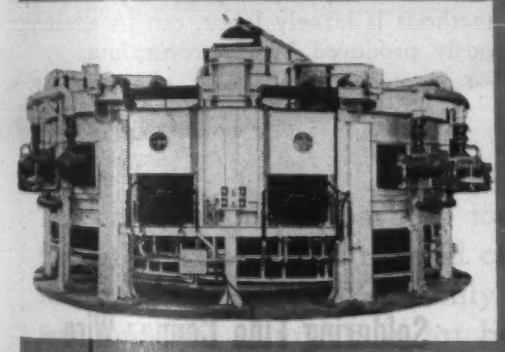

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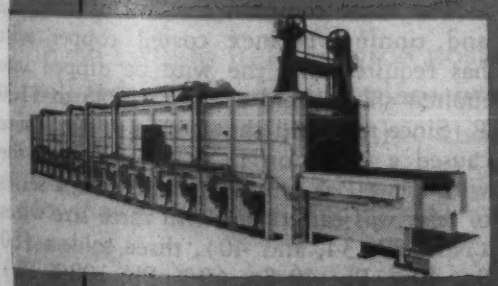

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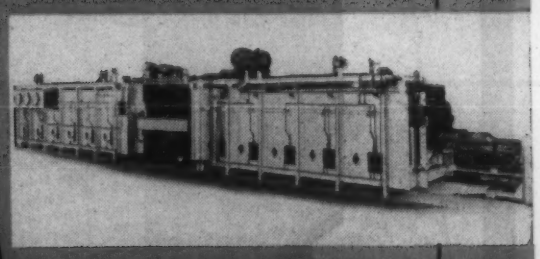

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These cabinets are built in two sizes, one having a work capacity of 5 cu. ft. and the other a capacity of 11 cu. ft.

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KOLD-HOLD

1.1 (1 gal.) is used on all molds. Vigorous agitation is used, consisting in most cases of a combination of work movement and solution agitation.

Pitting due to solid particles in the solution is prevented or minimized by filtration. Gas pits may be caused by "precipitation" of dissolved air as a result of temperature rise, by air bubbles which may enter through leaks in the filter intakes, or by small oxygen bubbles evolved at the anode which lodge on the cathode. By wrapping the anodes in vinylite cloth, the oxygen is retained until it is emitted in belches that do not adhere to the cathodes.

To be suitable for band instruments, thickness, hardness and grain size of deposits must be closely controlled. Use of insoluble anodes necessitates use of a corrosion cell to replenish the copper content of the plating solution. The corrosion cell is connected in series with the plating tanks, and the solution is continuously circulated from the corrosion cell to the plating tanks, then back to the corrosion cell.

In the corrosion cell, the cathode is a large copper disk that rotates slowly in a sulphuric acid catholyte, separated from the anolyte by a micro-porous rubber diaphragm. The small amount of loose powdery copper which deposits on the cathode is removed by a scraper. It drops into a sump below the cathode and is removed by secondary circulation through a filter.

If an ordinary porous diaphragm is used, the copper powder which falls against the diaphragm becomes an intermediate electrode, copper depositing on the side near the anode until the diaphragm pores are plugged with copper.

Scrap copper in baskets is the anode material used in the corrosion cell. Items that are difficult to produce by mechanical methods and for which the cost by mechanical methods is largely labor, can be advantageously produced by electroforming.

—F. K. Savage, R. M. Fiandt, D. B. Reid & P. R. Pfefferle. *Proc.*, Am. Electroplaters' Soc., June 1944, pp. 173-190.

Soldering Fine Copper Wire

Condensed from "Wire and Wire Products"

The most common method of stripping and tinning Formex coated copper wire has required that the wire be dipped into molten solder held at about 1025 to 1100 F. Since tests had shown that this exposure caused a reduction in the diameter of the wire as well as some embrittlement, a series of tests was carred out with three size wires (Nos. 29, 34, and 40), three solders (60 Sn, 40% Pb; 40 Sn, 60% Pb; 100% Pb) and a number of temperatures.

The wires were first stripped of the Formex by a new method using two chemical solutions, since it was known that the Formex was unaffected at temperatures under 1000 F. The destruction time under the various conditions was determined.

The life and diameter of any small-to-fine size copper wire in any solder is decreased with increasing molten solder temperature. The higher the tin content of tin-lead solder, the shorter is the life of a given wire

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MICHIANA has specialized in the alloy division of the foundry industry for over a quarter of a century. During this time a vast number of different alloys, with varying chemical compositions and physical properties, have been successfully produced.

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Further details, illustrations, designs and stress tables are included in Bulletin 110. Send for your copy today.

MICHIANA PRODUCTS CORPORATION
Michigan City, Indiana

in that solder at any given solder temperature. Unfortunately, an all lead solder gives a considerably weaker solder joint than a tin-lead solder. For a given solder composition and temperature, the finer the wire, the shorter is the wire life in that solder.

On the basis of these tests, the best all-around solder appears to be the 40 Sn-60% Pb, but for other purposes the 60 Sn-40% Pb may be best. Some form of wire weakening or loss of tensile strength may be imparted to the copper wire from the tin-lead solders at around 1000 F. It is believed this effect as well as the rapid destruction of the wire may be due to the formation of a low melting point alloy of tin and copper.

It is clear that a low solder temperature should be used for tinning or making joints in wire sizes finer than about No. 30-32; preferably, the temperatures should be within 150 to 200 F. of the solder melting temperature or under 600 F.

Since the destruction time is so short at the temperatures required to strip Formex, a low temperature insulation stripping method other than the hot tin dip becomes necessary. Other high temperature methods, such as gas flame methods, tend to introduce wire embrittlement and oxidation, and are no better.

No further details are given on the chemical solution stripping method mentioned as now in use.

—R. H. Bailey. *Wire & Wire Products*, Vol. 20, Mar. 1945, pp. 197-199.

Rolled-On Aluminum Fins

Condensed from "The Iron Age"

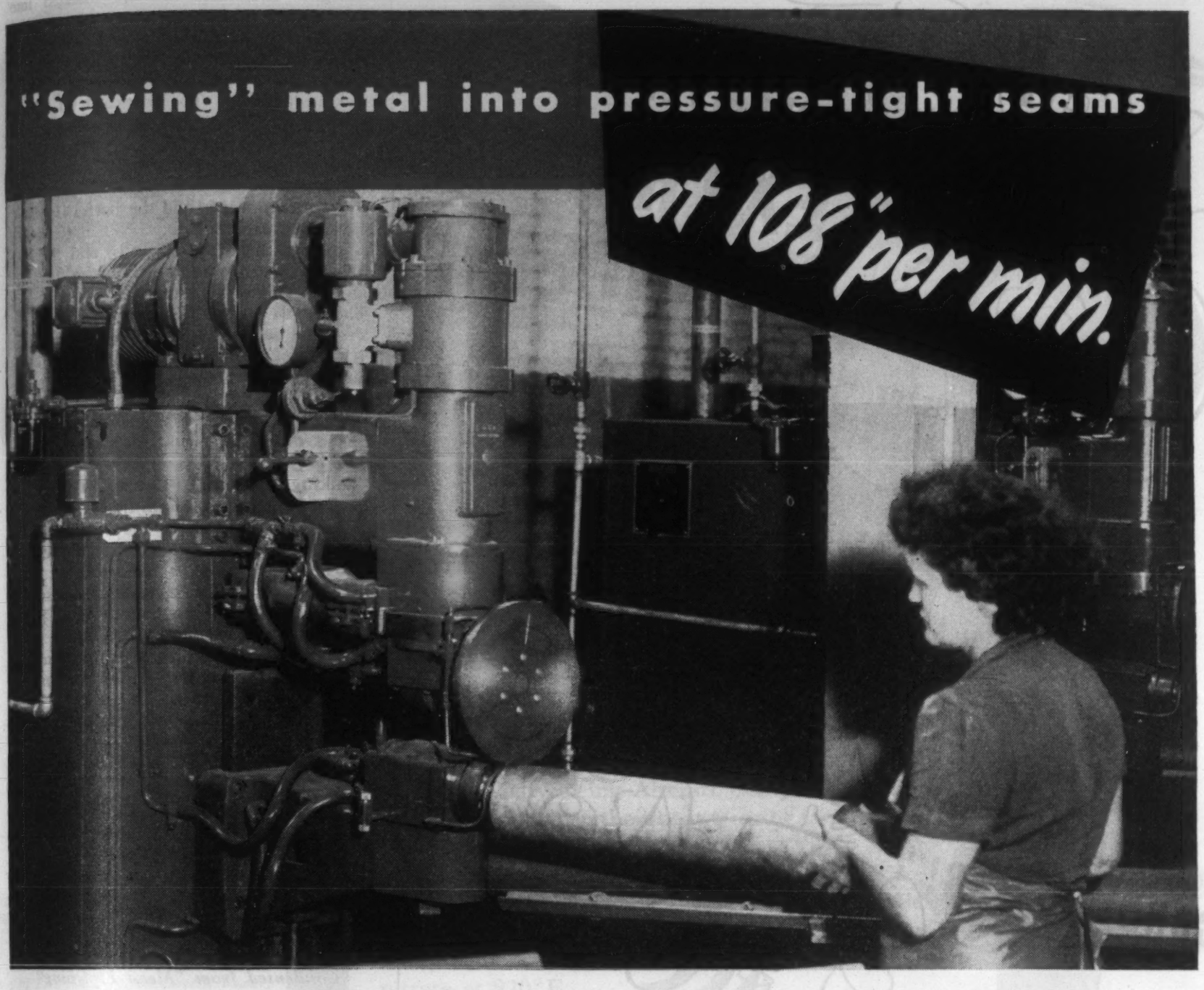
Demands for increased power for air cooled aircraft engine cylinders required greater heat dissipation, and a sheet aluminum fin seemed to offer the best possibilities. A successful method of anchoring of fin was accomplished with a "W" form developed by W. B. Bronander.

The fin is made from 0.025-in. thick dead soft aluminum strip (AS 4001) containing 1% of impurities. It is produced by progressively rolling the strip into the form of a letter "W" with two outside legs 1-in. or more in height, and center only ⅛-in. high. It is automatically coiled into a drum. The coil is cut into accurate half circles in a Scondia machine.

The aluminum fin offers a decided advantage in that, if damaged, it may be straightened by hand. In case fins are cut away by enemy fire, they may be replaced. Test cylinders have been heated to 500 F. and cooled to 50 F. below zero. To remove fins, a cut is made through the root of the fin, which can then be lifted out.

With the exception of the fin-cutting operation, the manufacture of the new cylinder barrel is the same as the old one. Fay automatic lathes used to cut 46 fins are now used to cut 30 grooves. These are 0.016 to 0.119 in. wide and 0.125 in. deep. At the root is a ⅛-in. radius, blending into the sides with 1/64-in. radius.

After the cylinder head has been screwed and shrunk on the barrel, fins are assembled on a special machine designed by



Lessons learned in SEAM WELDING war materials can cut <u>your</u> post war fabricating costs

Send for your copy.

Seam welding operations, like the one above at General Outdoor Advertising Co., Jacksonville, Fla., are teaching us much that can apply to peace time products. Refinements in machine design, developments in special conveyors and jigs, can cut production time on many items. Using uninterrupted current, speeds up to 108" per minute can be reached on thin gauges. Heavier stock requires interrupted current and may be welded into pressure-tight seams as fast as 78" per minute.

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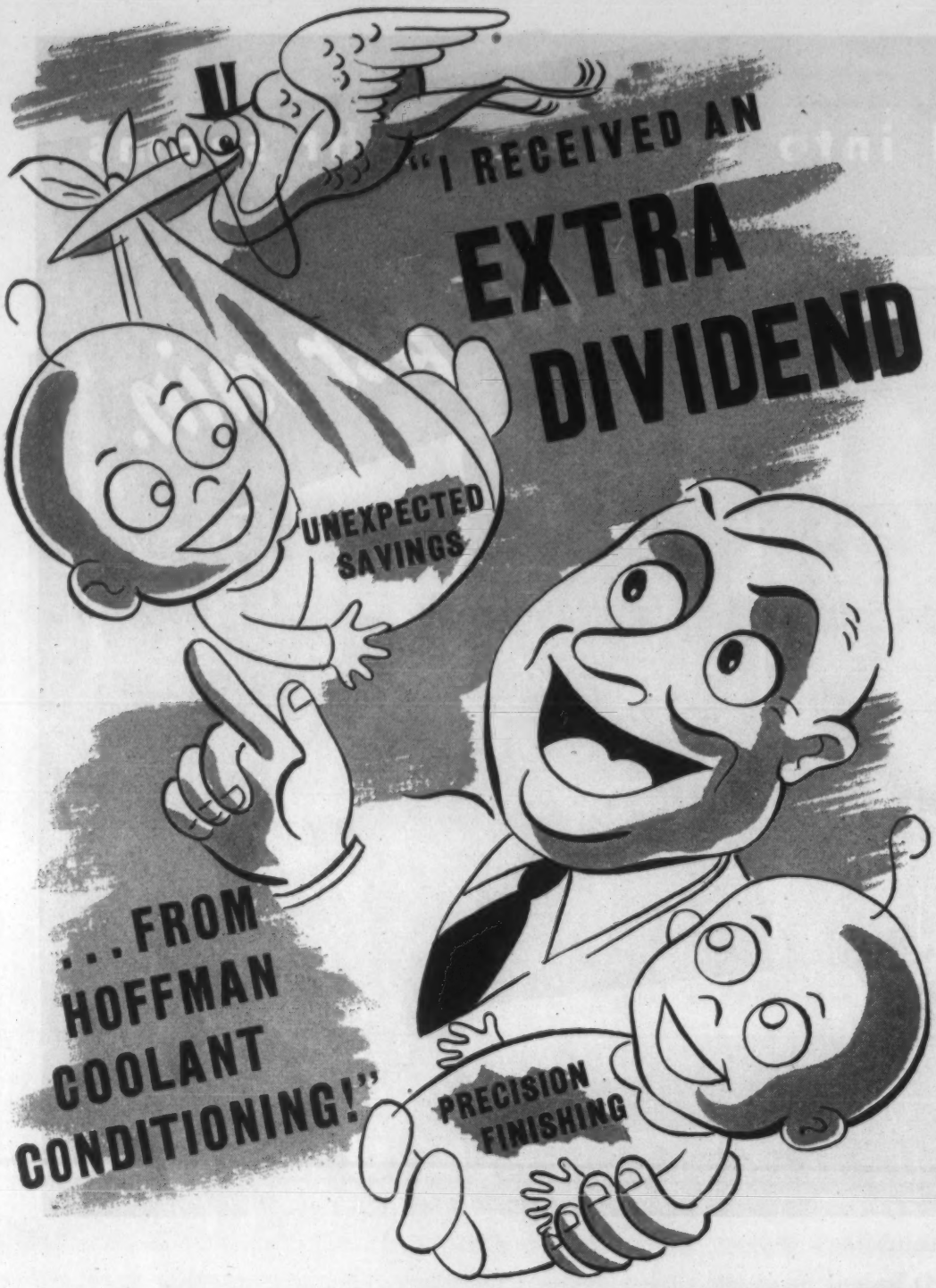
ELECTRIC RESISTANCE WELDING EQUIPMENT



"Yes, sir, I found twin blessings in Hoffman coolant conditioning. It not only safeguards the quality of our precision finishing; it also paid for itself in a few months through savings in maintenance, in longer life for machines, cutting tools and grinding wheels, and in reduced coolant replacement costs."

POUGHKEEPSIE PLANT NO. 1

At right: Hoffman centralized installation for filtering coolant from a large number of machines. Other Hoffman models are available for individual machine tools.

SEND FOR LITERATURE

U. S. HOFFMAN MACHINERY CORPORATION
223 Lamson St., Syracuse, N. Y.
COOLANT FILTERS • FILTRATION ENGINEERING SERVICE

Wright. Individual fins are inserted into two magazine blocks. Spacing is controlled by means of narrow steel blades fitting between the legs of the "W", each of which carries three small projections to serve as staking punches. The first pair of blocks takes fins Nos. 1, 3, 5, etc., while a second pair takes Nos. 2, 4, 6, etc.

A pair of loaded blocks is inserted into holders connected to pistons of two opposed hydraulic cylinders, and the barrel is placed over an expanding arbor. When the pedal is tripped the arbor expands, and the two blocks move inward, pressing the fins into grooves and staking them at three points. The blocks are withdrawn and replaced by a second set, and the cylinder is indexed 90°. The cam or index plate moves cylinder outwards an amount equal to spacing between fins.

Fins are caulked into place, assembly is placed on rotating arbor, and a set of spacers is engaged in the spaces between the fins. Caulking is performed by a series of narrow blades, which are fed into the W's.

A cut is made across the outside of the fin on a hydrotrol lathe. From the top 20 fins about 1/16 in. is removed, but from here the depth of cut increases progressively until the height of the bottom fin is 3/8 in. Burrs are removed on a speed lathe.

A final operation consists of crimping for stiffening purposes. Painting or metallizing is not required.

—*Iron Age*, Vol. 155, Feb. 22, 1945, pp. 66-70.

Plating Fine Steel Wire

Condensed from "Metal Finishing"

Before the war, America consumed as much as 25 tons per month of virgin nickel metal for filament supports in incandescent lamps. As a result of the war-time shortage of nickel, it became necessary to reduce the amount of nickel used for this purpose by substituting nickel-plated iron wire. For this application, the nickel plate must have excellent adhesion and good ductility.

The wire, ranging in size from 0.01 to 0.09 in. diam., is received in 8-in. diam. coils, is unreeled and fed into the plating line, passed successively in a straight horizontal path through a soak cleaner, an alkaline electrolytic cleaner, a cold rinse, an electrolytic pickle, a cold rinse, the nickel plating cells, final cold and hot rinses, and then through the tension unit and coiler. The tension on the wire is kept low and bends are avoided, in order to prevent work-hardening of the wire.

There are 5 plating cells in series, each 24 by 12 by 40 in. The anodes are laid horizontally below the wire, electrical contact to them being made by means of carbon blocks on which the anodes rest. Each cell has its own tank rheostat, ammeter, and voltmeter. The line speed is 10 to 15 ft. per min. for 0.0002 in. coated thickness.

The nickel bath is a concentrated low pH Watts solution, containing nickel sulphate, 32 oz. per gal.; nickel chloride, 3 oz. per

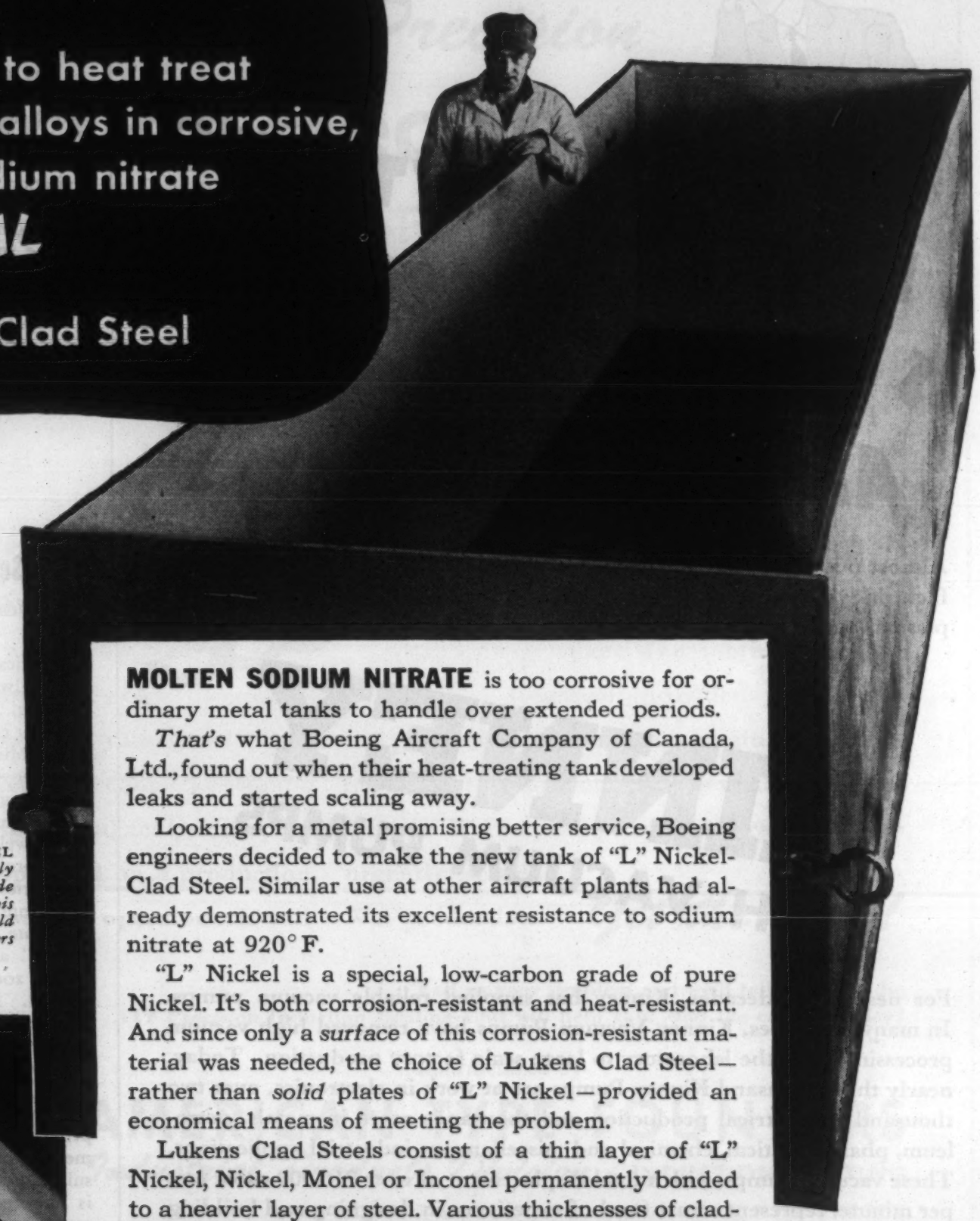
(Continued on page 1724)

THE JOB

Tank used to heat treat aluminum alloys in corrosive, molten sodium nitrate

THE METAL

"L" Nickel-Clad Steel



LUKENS "L" NICKEL-CLAD STEEL HEAT-TREATING TANK—*Approximately 21'x5'x4'. All-welded construction. Made of ¾" 20% "L" Nickel-Clad Steel. This tank is filled with sodium nitrate and held at 920°F. by electric immersion heaters 24 hours a day.*

PROTECTION FOR HEATER ELEMENTS, TOO!—*Installed tank, showing electric immersion heaters in place. Pure NICKEL sheathing protects the heater elements against corrosion and embrittlement by molten sodium nitrate salts.*

MOLTEN SODIUM NITRATE is too corrosive for ordinary metal tanks to handle over extended periods.

That's what Boeing Aircraft Company of Canada, Ltd., found out when their heat-treating tank developed leaks and started scaling away.

Looking for a metal promising better service, Boeing engineers decided to make the new tank of "L" Nickel-Clad Steel. Similar use at other aircraft plants had already demonstrated its excellent resistance to sodium nitrate at 920° F.

"L" Nickel is a special, low-carbon grade of pure Nickel. It's both corrosion-resistant and heat-resistant. And since only a *surface* of this corrosion-resistant material was needed, the choice of Lukens Clad Steel—rather than *solid* plates of "L" Nickel—provided an economical means of meeting the problem.

Lukens Clad Steels consist of a thin layer of "L" Nickel, Nickel, Monel or Inconel permanently bonded to a heavier layer of steel. Various thicknesses of cladding are available. (The job determines the proper INCO Nickel Alloy and thickness to be used.)

If corrosive conditions exist in your plant, too, investigate clad steels. A booklet, *"Lukens Clad Steels,"* shows how you can plan and build corrosion-resistant equipment at reduced material cost. For your copy, write:

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NICKEL (INCO) **ALLOYS**

MONEL • "K" MONEL • "S" MONEL • "R" MONEL
"KR" MONEL • INCONEL • "Z" NICKEL • NICKEL
Sheet . . . Strip . . . Rod . . . Tubing . . . Wire . . . Castings . . . Welding Rods (Gas and Electric)

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Almost nothing (high vacuum) has played an important part in manufacturing or processing: electronic devices, light bulbs, dried blood plasma, and countless other products.

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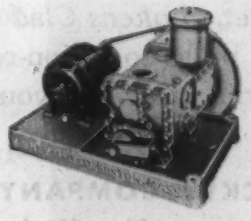
For nearly two decades, Kinney has supplied reliable vacuum pumps. In many industries, Kinney Vacuum Pumps have removed high vacuum processing from the laboratory to large scale factory production. Today, nearly three thousand Kinney Pumps are at work in electronics, over two thousand in electrical production and thousands more in metals, petroleum, pharmaceutical, chemical and miscellaneous industrial applications. These vacuum pumps, with a total displacement of over 710,000 cubic feet per minute, represent a vast fund of experience in designing and building pumps for the specialized service of creating and maintaining low absolute pressures.

Let Kinney figure out your vacuum pumping problems



Model CVD Compound Dry Vacuum Pump. Low absolute pressures 0.5 micron or better.

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gal.; boric acid, 5 oz. per gal.; pH, 2.0; temperature, 140 F.; cathode current density, 200 to 600 amp. per sq. ft. The limiting anode current density was found to be about 125 to 150 amp. per sq. ft. Higher anode current densities resulted in liberation of chlorine.

The nickel solution is pumped continuously from a sump tank into the cells, from which it overflows back to the sump. The high speed turbulent flow through the cells produced in this manner gives excellent agitation. A portion of the solution is continuously filtered, so that it is always free from dirt and impurities.

The spooling table carries 4 rows of 14 spools, *i.e.*, it handles 56 strands. The line has an average daily output of over 1,000,000 ft. of unformly plated wire.

—J. H. Conolly & Richard Rimbach. *Metal Finishing*, Vol. 43, Mar. 1945, pp. 97-99, 101.

Sequence in Ship Welding

Condensed from "Transactions of the Institute of Welding"

Practical constructional methods and processes always govern production in ship welding, and there should be, therefore, constant co-ordination between the designer, the welding engineer, and the foreman. A designer can obviate many difficulties by specifying the widest possible plates with a minimum of welding and by locating many welds where the nature of the ultimate problems may be predicted and the difficulties kept under reasonable control.

In considering the suitability of the parent plate or section for welding, the "disturbed" area adjoining the weld and the fusion zone or weld proper must be considered. For the most part, the highest heat input combined with the slowest possible welding speed will have the least adverse effect upon the physical properties of the disturbed area.

The fusion zone or weld proper comprises re-melted parent metal plus molten metal from the electrode core wire. The suitability of the parent plate for re-melting is important. Unsuitable steelmaking processes are reflected in gas evolution. When welding certain steels, it is preferable to use the lowest possible current with the highest possible speed to minimize dilution of the weld.

Strict adherence to the welding specification, while essential, is not a safeguard against distortion and shrinkage. Therefore, erection sequence drawings should be prepared for all major parts of the ship's structure. Every joint should be carefully considered and designed to give maximum strength with the least amount of deposited weld metal.

Full details of the plate preparation should be given, and it should be indicated whether butt joints are to be made from the inside or outside. As far as possible, butt joints should be designed to allow for downhand welding. Welding specifications should be embodied on every plan, and length o

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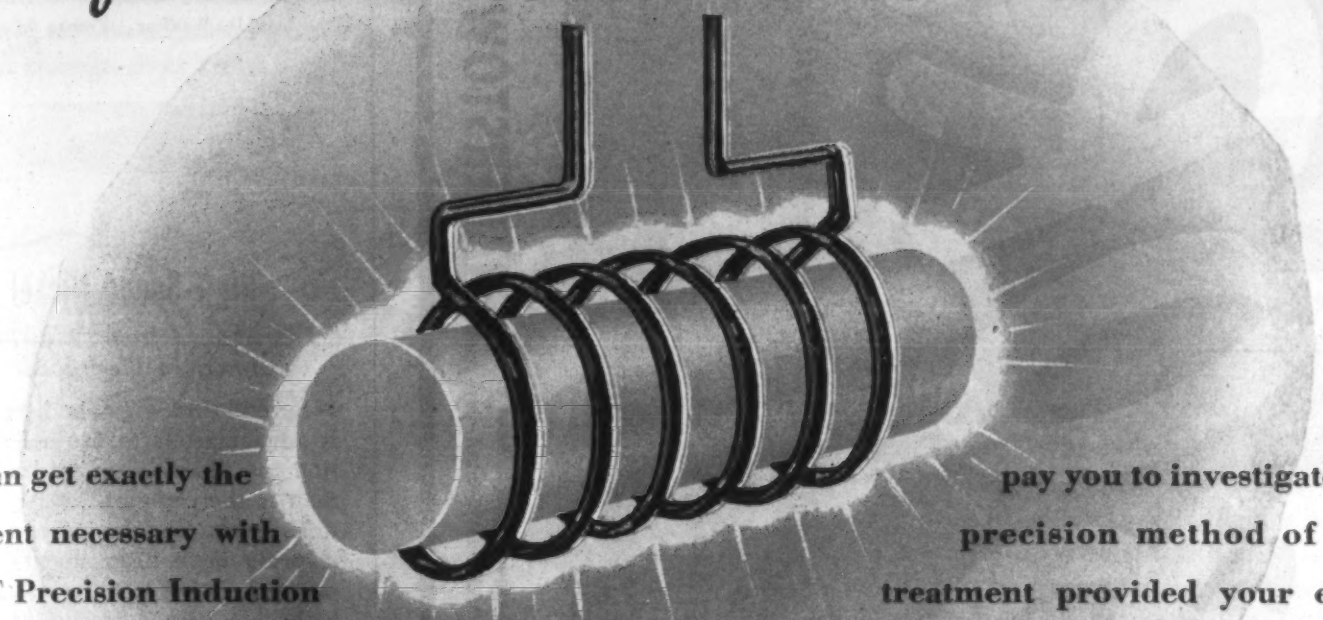

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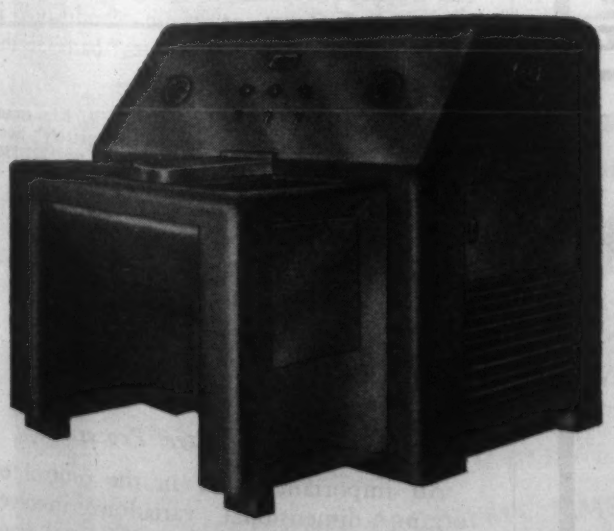

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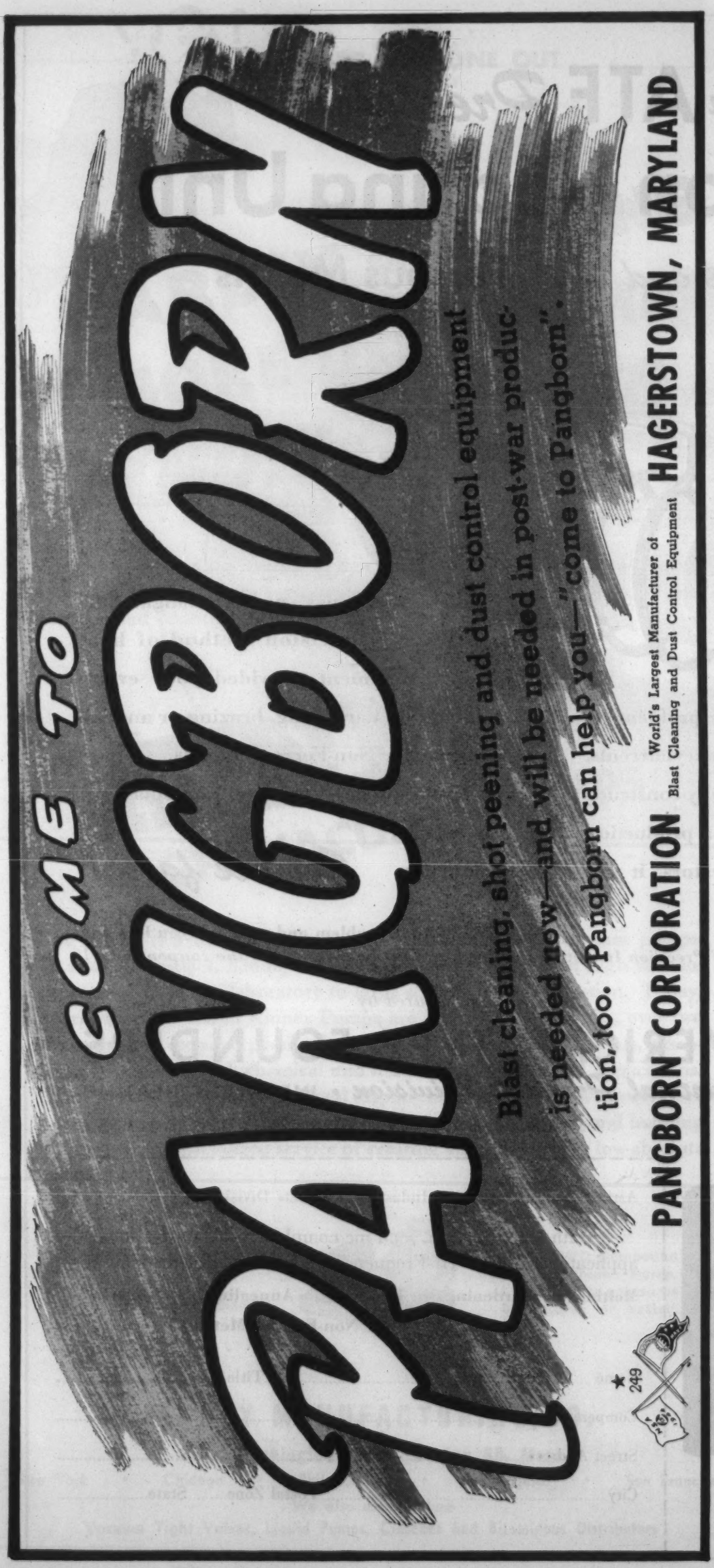


deposit should be standardized as far as possible.

The erection sequence of the main structure is as follows: Keel plate, flat of bottom shell plating, longitudinal bulkheads, vertical center keelson, transverse bulkheads in center tanks, bottom longitudinals in center tanks, bottom transverses in center tanks, transverse bulkheads in wing tanks, bottom longitudinals in wing tanks, bottom transverses in wing tanks, side frames and knees, upper deck center girder, deck transverses in center tanks, struts in wing tanks, deck transverses in wing tanks, stringers to shell, upper deck plating, and side shell plating.

—Jack D. Wadling. *Trans., Inst. Welding*, Vol. 7, Nov. 1944, pp. 116-118.

High-Speed Nickel Plating

Condensed from "Monthly Review", American Electroplaters' Society

Several investigators have found that it is advantageous to use a higher concentration of chloride in nickel plating baths than is the common practice. Plating solutions containing no other salt than nickel chloride have been investigated and have many desirable properties. However, these baths are very corrosive and have an unstable pH.

A solution based on both nickel sulfate and nickel chloride, but with a high enough chloride concentration to retain the desirable properties of the all-chloride type of solution, is described. The advantages listed include good pH control, ease of purification, high current density operation, compatability with certain organic brighteners, high solution conductivity, high cathode efficiency, and desirable deposit characteristics, such as improved ductility, smoothness of thick deposits, ease of buffing, and substantial freedom from pitting.

The bath finally selected contains nickel sulfate, 200 g. per l.; nickel chloride, 175 g. per l.; boric acid, 40 g. per l. Optimum operating conditions for a semi-bright plate are: Temp., 115 F.; pH, 1.5. At these conditions a current density of 11 amp. per sq. dm. (100 amp. per sq. ft.) is readily usable, resulting in 0.001-in. deposit thickness in 11 min. Twice this current density can be used without burning. The cathode current efficiency at these conditions is 98%, while that of a Watts' bath at the same pH is 80%.

—W. L. Pinner & R. B. Kinnaman. *Mo. Rev.*, Am. Electroplaters' Soc., Vol. 32, Mar. 1945, pp. 227-234.

Forging Die Design

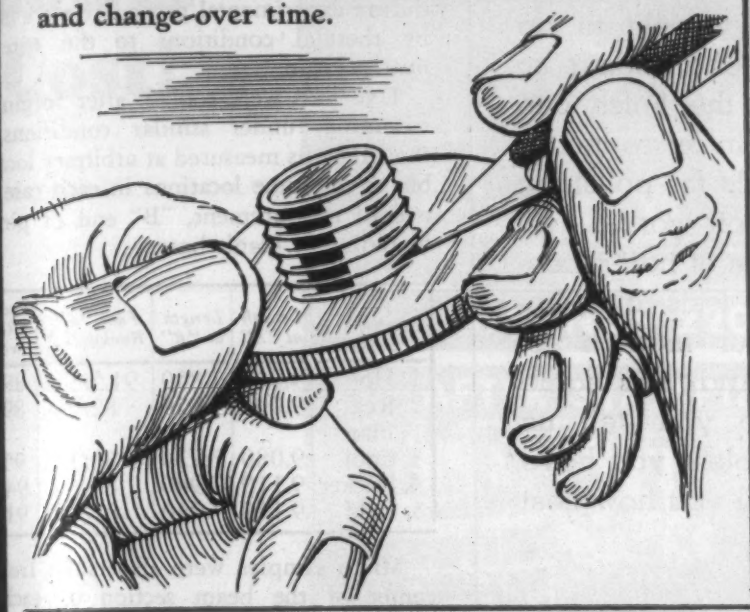
Condensed from "Steel Processing"

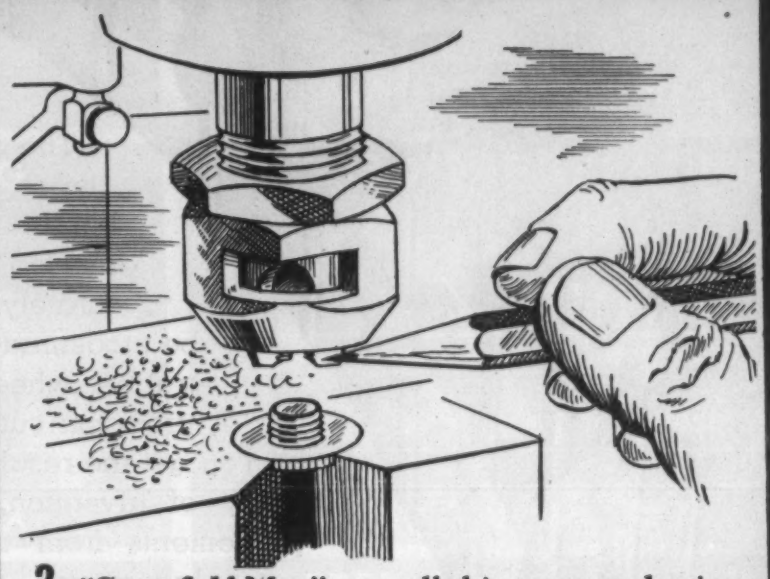
An important factor in the control of forging dimensional variations involves "shrinkage"—the contraction of metal from forging temperature to that of normal. There

THREADING SMALL PART WAS HEADACHE . . . UNTIL "GREENFIELD MAN" SHOWED HOW WITH "ACORN" DIE

[A GTD SHOW-HOW REPORT]

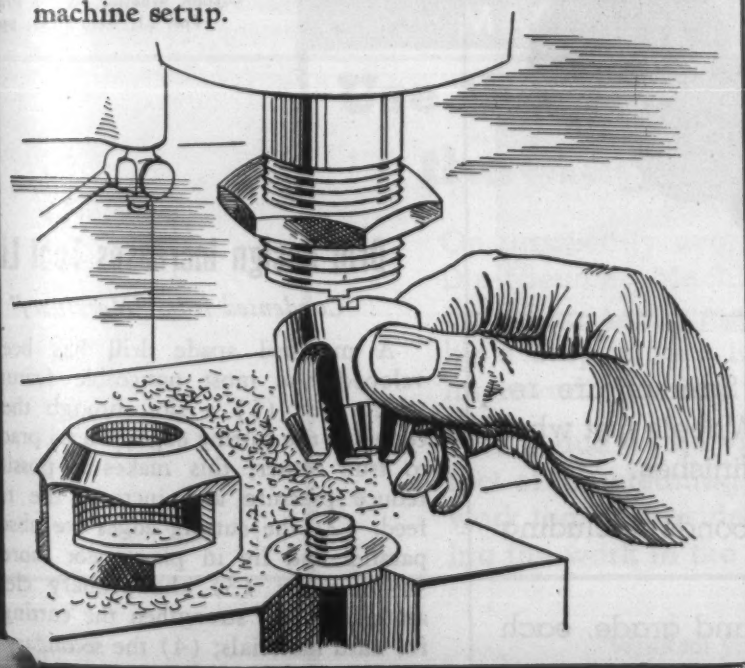
1 They were cutting an external thread on a zinc die casting. The thread length was only half an inch but it had to go to the bottom of the flange. The method in use would not deliver at high speeds, could not be adjusted quickly, required long setup and change-over time.

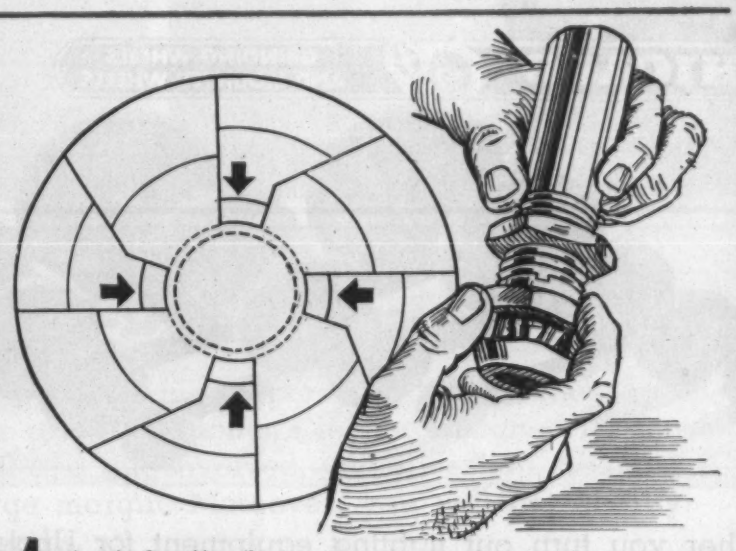




2 "Greenfield Man" was called in, suggested using an "Acorn" Die setup. Pointed out that "Acorn" Die allows threading as close to shoulder as desired since lands project out past the holder, (chamfered threads can easily be ground down by the operator or can be supplied already ground down).

3 He SHOWED HOW, by simply unscrewing the cap, the "Acorn" Die could be easily taken out of the holder for resharpening without disturbing the machine setup.





4 And finally, he pointed out how screwing on the cap compresses all four die lands to give a concentric adjustment. Accuracy of final adjustment is assured by the ground taper on the inner face of the adjusting cap which affords a perfect seat for the die lands.

Results!

The customer's own words: "The job was very troublesome . . . but thanks to the 'Greenfield Man' the trouble was over when we used an 'Acorn' Die. The R. P. M. of the Die is 1100 on and 2200 off. Production has been stepped up to 1200 pieces an hour."

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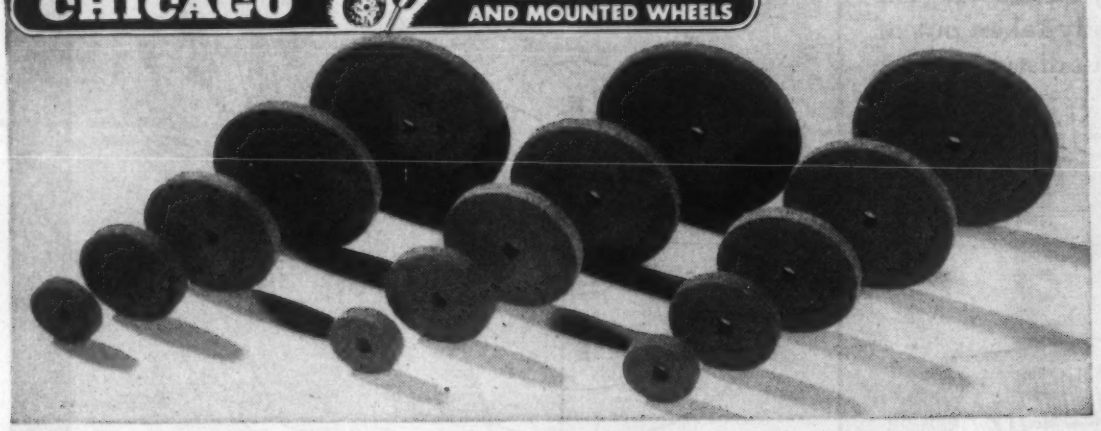

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appears to be a wide variation in shrink results, which depend on forging design, method used in making the part, and care put into the heating and forging operation.

Many forging designs demand irregular shapes. Thin sections chill quickly, temperature of the thin section drops to the low side when struck in the die, and steel is set for the length, depending upon forging temperature at the finishing blow. Relative volume of the forging and dies influence the temperature of the forging.

During the run of forging connecting rods, five rods were selected that covered a range of conditions experienced in the course of forging. Variations in shrink of rods during experimental procedure were effected by thermal conditions to the extent of nearly ⅛ in.

Five rods were cooled, after forging and trimming, under similar conditions, and their lengths measured at arbitrary locations, but at the same locations in each case: "A" overall measurement, "B" end of pin boss to radius of crank boss.

Rod	*Length at "A"*	*Length at "B"*	*Face "A" Rockwell B*	*Face "B" Rockwell B*
1. Hot	9.000	7.850	91.5/90	88/94
2. Regular	9.000	7.870	82/89	89/94
3. Cool	9.080	7.920	80/85	95/89
4. Sticker	9.110	7.940	88/91	94/93
5. Cold	9.110	7.940	87/92	91/98

Micro samples were also taken from the center of the beam section of each five rods and polished in a plane parallel to the flash at a distance half way from flash line to outer edge of the beam section. Rockwell B hardness tests were taken.

—John Mueller. *Steel Processing*, Vol. 31, Feb. 1945, pp. 97-99.

Drill Design Increases Tool Life

Condensed from "Machinery"

A modified spade drill has been developed, the most noticeable features of which are: (1) a slot through the dead center so the cutting edges extend practically to true center; this makes it possible to reduce pressure and increase the rate of feed; (2) the cutting edges are absolutely parallel and lie in planes not more than ⅛-in. apart; (3) the primary clearance angle is 7° to strengthen the cutting edge for hard materials; (4) the secondary clearance angle is 15° for more rapid penetration; (5) a rake angle of 7° gives added strength and forms a short curled chip; and (6) the point angle is changed from the conventional 59° to 80° to give an included angle of 160°, which decreases the length of the cutting edge and adds strength to the center of the drill. Due to the large included angle, it is necessary to chamfer the outer circumferential edge to aid in centering the drill.

In the first application of this drill, 4½-in. diam. holes 26-in. deep had to be drilled in SAE 4340 at about 205 Brinell. Conventional drills were very expensive and took a long time to drill the hole. A high-

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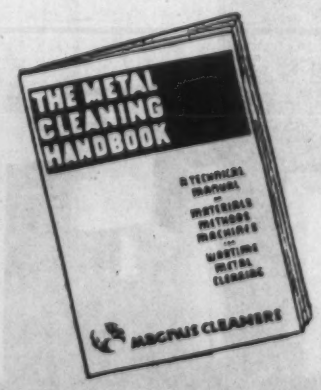
On practically every metal cleaning operation, the Magnus Aja-Dip Cleaning Machine and the Magnus Cleaner designed for the particular work, metal and dirt involved, will speed up cleaning by a surprisingly large margin. Moreover, you will get greatly improved cleaning results.

This is due to the vigorous, many times repeated "swishing" contact of the cleaning solution with all surfaces *and recesses* of the work that is provided by the Magnus method of raising and lowering the work *in* the solution.

Write for your copy of the Magnus Metal Cleaning Handbook—the complete manual on metal cleaning methods, materials and machines. When you've read it, then ask us to recommend the method and the cleaner best adapted to your work.



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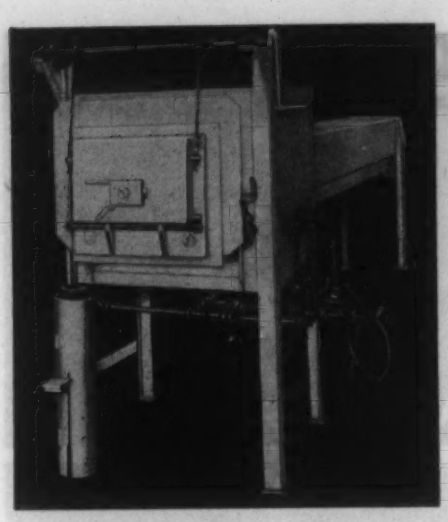
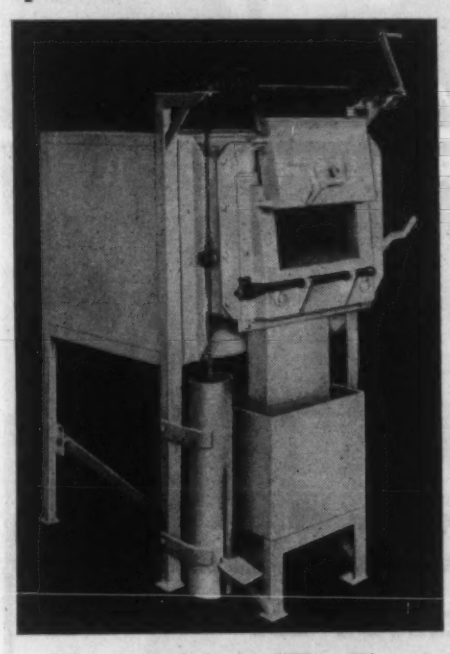


Kleenmetal Series KMC—Gas fired, muffle furnace with preheat section and cooling chamber; may be oil fired or electric; designed for controlled atmosphere. Streamlined, rugged design; inclined door with foot treadle operation.



Kleenmetal Series KD—Electric furnace, direct heated, with preheat section and internal chute to quench tank; may be oil or gas fired; chute may be omitted; inclined door with small door and sight hole; foot treadle or hand lever operation. Equipped for use with controlled atmosphere, if desired.

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Controlled Atmosphere

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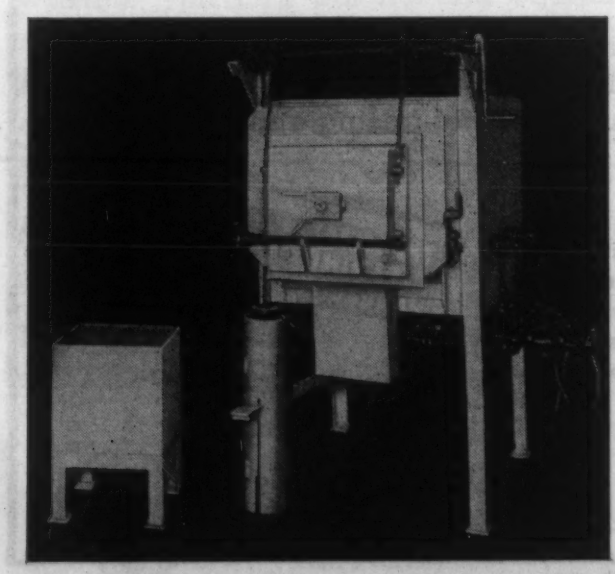
Here are your truly versatile tool room furnaces designed for any small batch heating operation between 1400° and 2500° F. Built with or without carborundum or alloy muffles to suit operating conditions, they may be gas or oil fired or electrically heated and are provided for introduction of any kind of protective gas. All furnaces are equipped for both foot treadle and hand operation of door.

Series KM or KD are equipped with internal chute leading to quench tank. Series KMC or KDC has a water cooled cooling chamber at rear of furnace. Both types have a long preheating chamber.

These furnaces are available in several practical sizes. Bulletin No. 417 gives full details. Write.



Kleenmetal Series KM—Gas fired furnace with preheat chamber and internal chute to quench tank; carborundum muffle optional; may be oil or electric; available also without chute; inclined door with foot treadle or hand lever operation. Equipped for use with controlled atmosphere.

★

★

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speed steel spade drill required 2 to 2½ hr., broke frequently, and required regrinding after each hole.

A modified spade drill of the design described made of high-speed steel took only 47 min. to drill the hole and seven holes were drilled before regrinding became necessary. A similar modified spade drill with carbide tips did the job in 36 min. with seven holes between grinds. However, the speed of the drilling machine was not adequate to give the optimum speed for the carbide tipped drill.

This application was so successful that similar modified spade drills were tried elsewhere and conventional twist drills were likewise modified along these lines. The latter proved surprisingly good, especially in drilling hard steels. By means of this modification, the number of holes between grinds is increased by 10 to 13 times that obtained with conventional twist drills.

About 1200 drills with diameters from ¼ to 1 3/16 in. have been modified as follows: (1) Square off end of drill; (2) place in collet chuck of tool grinding machine and line up so the lips are horizontal; (3) rotate about its own axis through 15° so the lips can be ground 15° from original; the head of the grinding machine is then turned through 7° to form a 7° positive rake; (4) the head is turned so the end of the drill is raised 7° for the primary clearance and the head is turned through 10° to form the point angle; both lips are ground to a primary clearance of 7°; (5) the end of the drill is raised further to 15° for the secondary clearance.

Keeping the same 10° point angle, the grinding is started at the back of the lip and continued until the primary land with a clearance angle of 7° is cut down to the desired width; (6) grinding machine head is turned through 45° to grind a chamfer around the outer circumferential edge; a back clearance of 12° must be provided; and (7) the drill is turned about its axis through 7° to grind the slots, which must be in dead center and never over 1/16-in. wide.

—R. W. Parkinson. *Machinery*, Vol. 51, Mar. 1945, pp. 156-161.

Superimposed AC for Plating

Condensed from "Steel"

Promat Div., Poor & Co., Waukegan, Ill., has developed a new process for electroplating zinc on steel. An important feature is the use of recently developed metallo-organic compounds, which make available zinc in a new and highly platable form. The result is unusually efficient plating action, even with conventional d.c. power sources.

The most significant feature is the use of a.c. superimposed on the usual d.c. One method allows the full d.c. load of the generator or rectifier to be passed through the secondary of the transformer from which the a.c. is obtained without causing distortion of the wave form. A sinusoidal

HOW TO SELECT THE FILTER THAT KEEPS FLOW ON "GO"

Send for this catalog of filter selection factors and specifications on Cuno Continuously-Cleanable Filters. (It's in SWEET'S MECHANICAL, PROCESS AND DESIGN FILES, but you may like an extra copy.) It gives you the information you need, arranged according to the recommendations of SWEET'S catalog designers, who learned from men like you how you want such information furnished.

In a word, the Cuno Continuously-Cleanable Filter handles full flow without requiring any more space than ordinary partial-flow types . . . filters as fine as 170 mesh equivalent (finer with certain models) . . . filters continuously, even while being cleaned . . . is applicable to low pressure or gravity feed systems (as well as others) . . . is all-metal, non-collapsible, permanent . . . is compact and lightweight . . . never needs to be disassembled for cleaning or renewing. May be equipped with motor to make cleaning completely automatic.

More about all that in the catalog — plus application listings, selective flow tables, types, sizes, dimensions and capacities. If you wish an extra copy of the insert in SWEET'S, send the coupon.

IF YOU HAVE "QUICK FACTS", YOU'LL ALSO WANT THIS
Cuno's booklet of "Quick Facts" is mostly about applications. This catalog is mostly about filter selection "know-how". You should have both.

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THE "FILTER-FINE" STRAINER

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with

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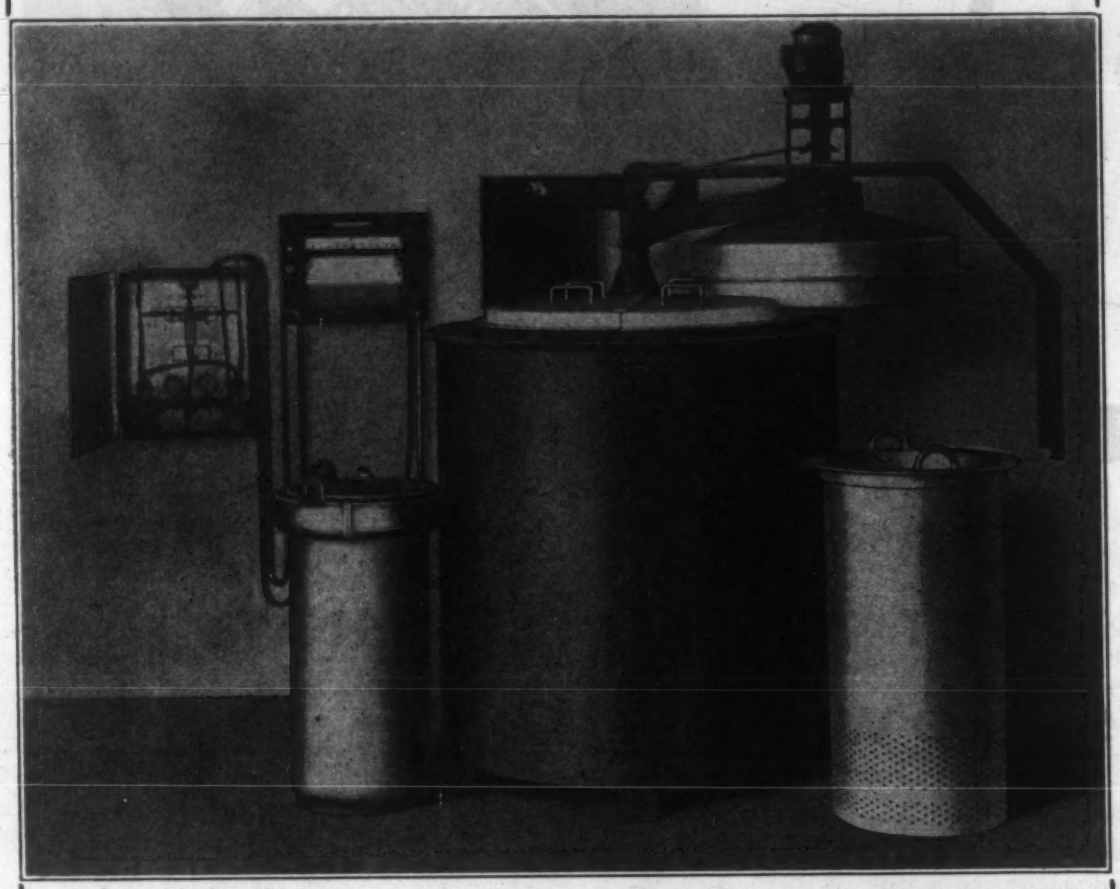

Model NA Air Tempering Furnace With Nitro Attachments

The pressure system together with precision control of time, temperature and flow of ammonia gas are resulting in unequalled advantages to the users of "AMERICAN" Electric Nitro Furnaces, and the "AMERICAN" Electric Air Tempering Furnaces with the Nitro attachments.

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Industrial Furnaces for All Purposes

wave with a valley value adjustable with respect to the zero axis is obtained.

Another method feeds the a.c. into the plating bath through specially designed anodes and a unique circuit that prevents feed-back effects between the a.c. and d.c. systems.

Usually just enough a.c. voltage is applied so that the effective plating current is reversed for but a small fraction of every cycle. The exact amount of reverse current and time it is applied must be controlled accurately. This reduces or eliminates anode passivity, resulting in increased plating efficiency.

Superimposition also affects hydrogen overvoltage. This in turn cuts down the "starting" voltage normally required to begin plating action, thus further increasing plating efficiency.

A more uniform thickness is produced, as superimposition knocks off excess deposits that normally tend to accumulate on edges and corners of the work, while at the same time building up the deposits in the hollow sections.

The most important advantage of the Promat process is that any current-density that can be obtained on the work may be used. This results in faster plating, greater output, smaller plating tanks, and large savings. The process is free from "burning" and other undesirable effects at all current-densities. High-quality finishes with a uniform, new brilliance are obtainable at any current-density from 5 to 120 amp. per sq. ft. The process works well in all types of standard plating equipment.

A similar process has been developed for plating cadmium on steel. It produces an exceptionally lustrous deposit at any current-density from 3 to 120 amp. per sq. ft. Extremely uniform color is obtained on irregularly shaped parts.

A new alkaline copper bath of the Rochelle type has been developed. This will not "burn" at a current-density twice that normally used in similar electrolytes. The deposit is ductile and soft, buffing easily to a high brilliance and excellent base for subsequent deposits. It is excellent for masking work for selective heat treating. Working temperature range of the bath is from room temperature to 180 F.

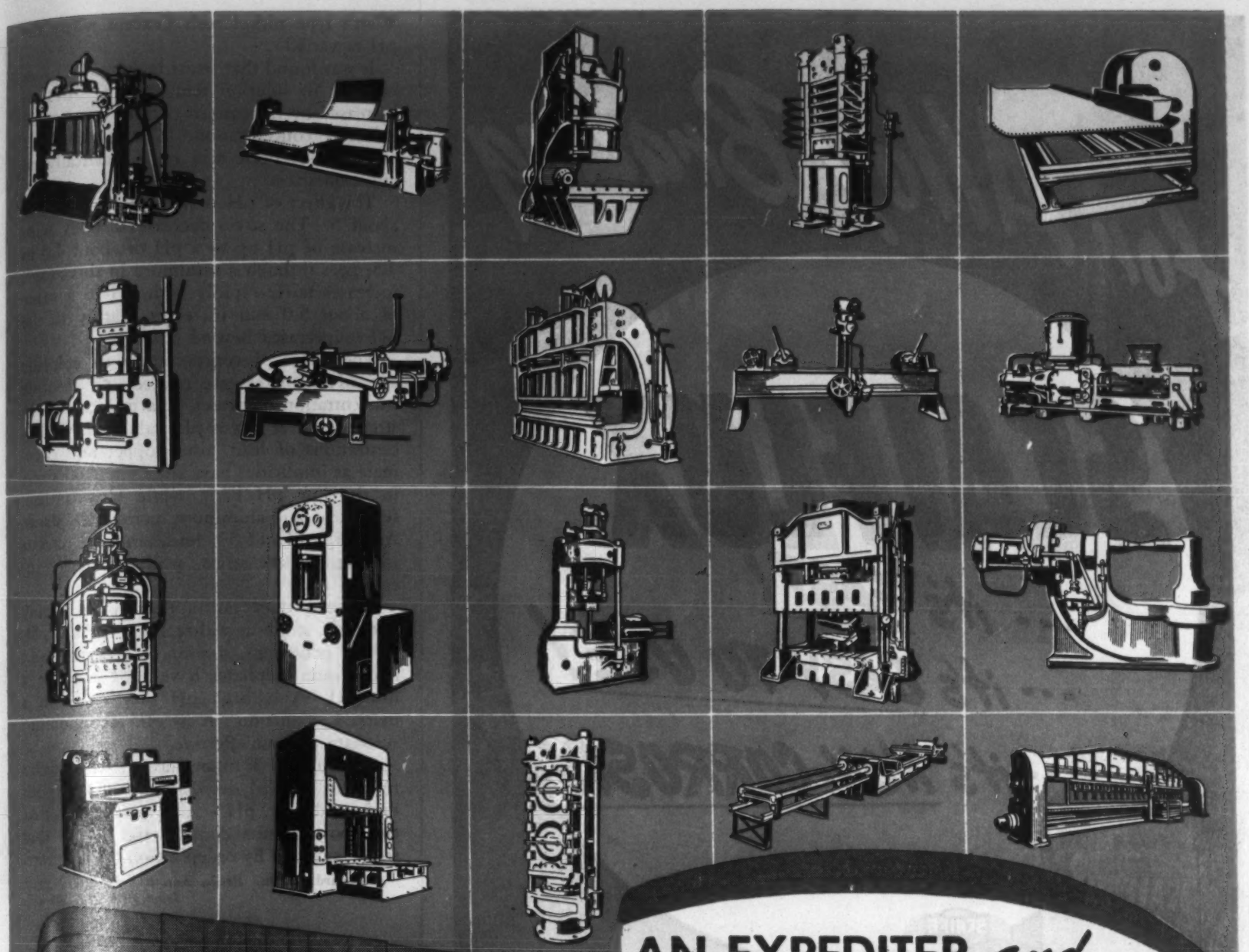
A second copper process depends largely upon superimposition for its results. It includes a simple cyanide bath and makes very efficient use of the d.c.

—G. W. Birdsall. *Steel*, Vol. 116, Mar. 12, 1945, pp. 108-109, 120, 123.

Stress in Nickel Deposits

Condensed from "Proceedings of the American Electroplaters' Society"

Stress in nickel deposits was measured by the contractometer method. In this method, the electrodeposited nickel produces a deflection of the thin steel strip on which the nickel is deposited. The magnitude of the deflection is taken as a measure of the stress. The solution used is a low pH



500 ton single-acting press with stripper in moving platen and provision for die-cushion. Controlled by either hand lever or push-buttons. Note the clean, compact design.

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Baldwin presses help you get jobs out quicker and cheaper today—and are excellent "life insurance" for companies that must meet uncertain competitive conditions tomorrow. Experience has proven that presses are at the top in the list of the most important modern production tools.

The sketches suggest the immense variety of sizes and types that Baldwin has built . . . and if the one you need is not among them, Baldwin will design it for you from the ground up. Hydraulic power plus special control features speed operation, increase capacity, reduce rejects, and add safety. Ask for Bulletin 160. The Baldwin Locomotive Works, Baldwin Southwark Division, Philadelphia, Pa., U. S. A. Offices: Philadelphia, New York, Chicago, Washington, Boston, Cleveland, St. Louis, San Francisco, Houston, Pittsburgh, Detroit.

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Try SCAIFLUX in your production brazing operations for speed, economy and highest quality. *Write for complete details today!*

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(Pittsburgh District),
OAKMONT, PENNA.

Watt's type nickel bath (except where the pH is varied).

It was found that stress is decreased by an increase in solution temperature. Stress is increased by increase in current density and chloride concentration. Concentration of nickel or of boric acid have practically no effect on stress.

The effect of pH is slight below a pH of about 5. The stress decreases slightly with increase of pH up to a pH of about 4.0 to 4.5, goes through a minimum in this range, increases fairly rapidly with pH to a value of about 5.0 and increases sharply as the pH is increased beyond 5.0.

The effect of concentration of chloride and pH on stress are related. As chloride concentration increases, sharp increases in stress begin at lower pH values. Low concentrations of lead, zinc, copper and chromate as impurities have little effect on stress in the low pH bath, while ferrous iron, ferric iron and aluminum increase the stress. At a high pH (5.5), lead, zinc and ferrous iron reduce the stress, while chromate increases it.

Calcium does not appear to have any effect on stress at either high or low pH. Added potassium, sodium, magnesium and ammonium sulphates have little effect at a low pH. At a high pH they result in a marked reduction in stress. Ammonium sulphate is most effective.

Addition of formate, acetate and citrate result in marked decrease in stress at both high and low pH. It is concluded that the above results confirm the theory that stress is caused by codeposition of a hydrate.

—Bernard Martin. *Proc.*, Am. Electroplaters' Soc., June 1944, pp. 206-217.

Silver Plating of Steel

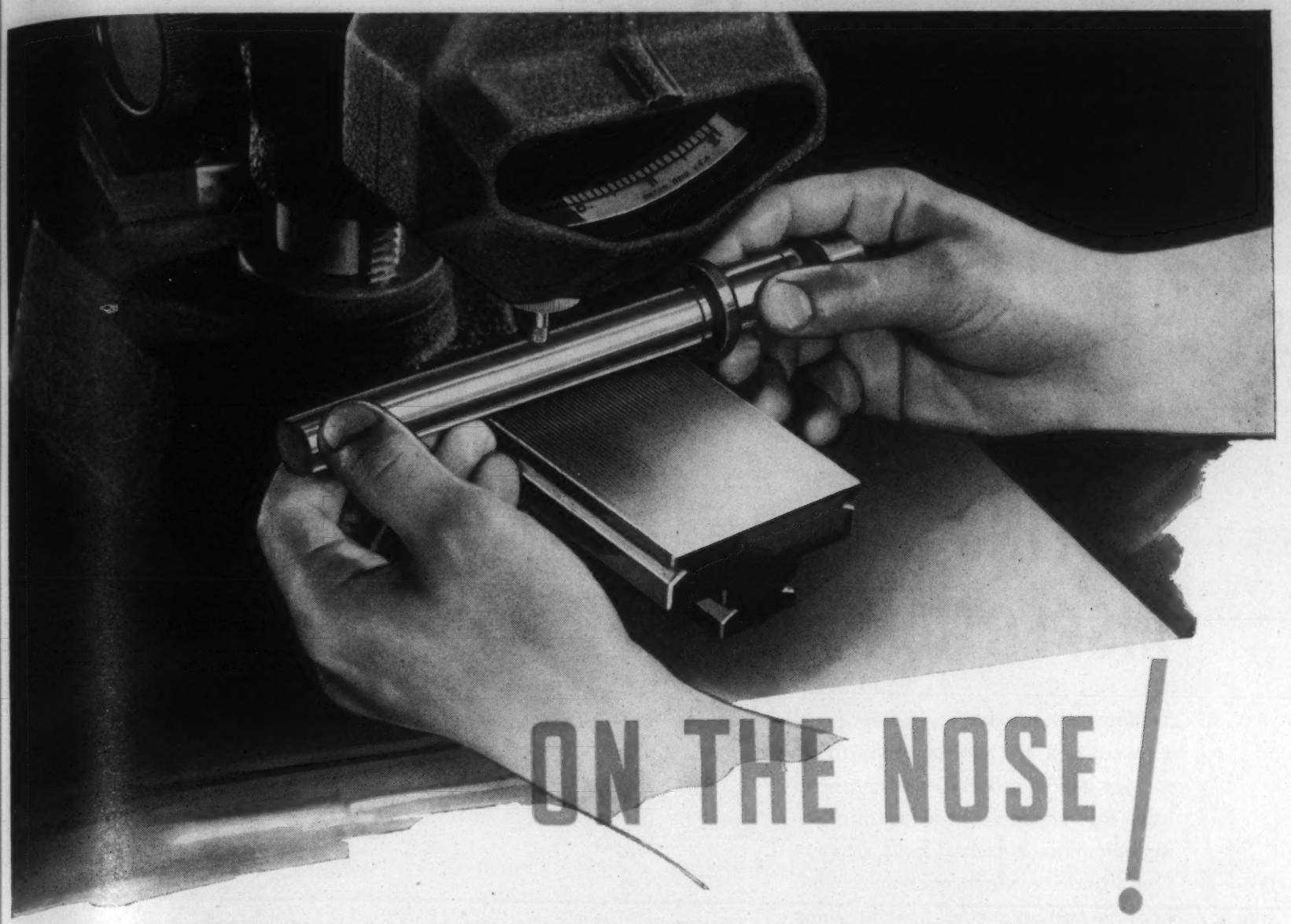
Condensed from "The Journal of the Electrodepositors' Technical Society"

Electrodeposited silver for heavy duty bearings must have excellent adhesion to the steel basis metal. A specification test permits no blisters nor evidence of poor adhesion after heating 1 hr. in air at 400 C. (750 F.). Direct deposition of silver on steel, using various strike compositions, silver over an undercoat of cadmium or nickel, did not yield satisfactory results.

The procedure found most satisfactory consists of the following steps: Anodic etch of the steel for 5 min. in 20% sulfuric acid at 20 amp. per sq. dm. (200 amp. per sq. ft.), rinse, plate with a minimum thickness of 0.00005 in. (0.00012 cm.) of nickel, rinse, plate with a minimum of 0.0001 in. (0.00025 cm.) of copper from an acid copper bath, rinse, dip 10 to 15 sec. in a solution containing 50 g. per 1. sodium cyanide, silver strike, silver plate.

The strike composition found best contains silver cyanide, 4.25 g. per 1.; sodium cyanide, 75 g. per 1.; sodium carbonate, 17.5 g. per 1.

—J. M. Sprague, *J. Electrodepositors' Tech. Soc.*, Vol. 20, 1945, pp. 39-46.



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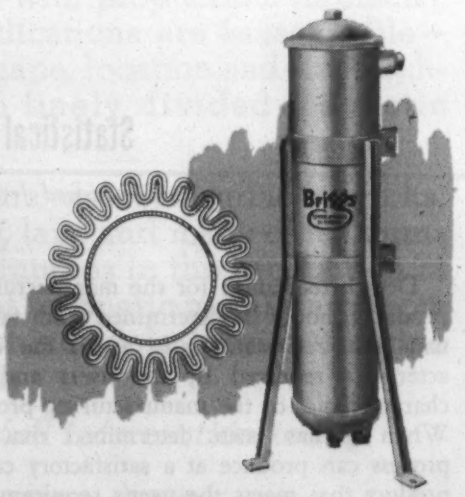
Effective filtration of coolants or cutting oils may be the solution to your "percentage of rejects" problem. Reduce that percentage and you'll increase your production just that much!

Briggs Coolant Filters . . . with unique Z-fold refill cartridge . . . have shown remarkable results wherever they have been installed. On one machine, production was doubled . . . on another machine, increased production paid for the Briggs filter the first day it was installed. In addition—coolant life was doubled . . . wheel and tool life considerably extended.

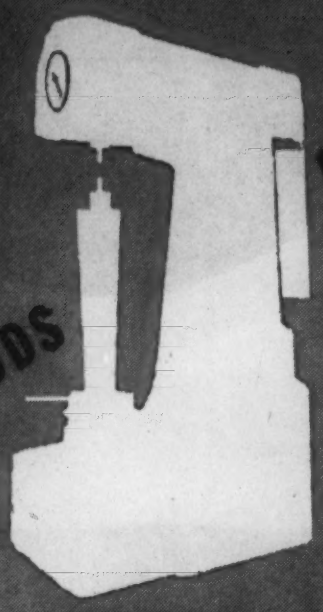
Briggs Filters are available for unit machines or for central systems. Capacities range from 3 GPM to 100 GPM.

Look in your local classified telephone directory under "Filter" . . . locate the Briggs distributor . . . have him show you the difference between Briggs Filters and ordinary filters. Or—write direct to manufacturer for illustrated literature.

Unique design and construction of Z-fold refill cartridge provides greatest possible filtering surface area and maximum flow rate. Cellulose is specially processed...from raw material to finished product . . . for filtration of liquids used as coolants.



BRIGGS CLARIFIER CO. **Briggs** PIONEERS IN MODERN OIL FILTRATION **General Offices, Washington 7, D. C.**



METHODS AND PROCESSES

TESTING and INSPECTION

Testing methods and equipment for physical and mechanical properties, surface behavior and special characteristics. Radiographic, spectrographic, identification, metallographic, dimensional and surface inspection. Stress analysis and balancing. Specifications, standards and quality control.

Statistical Control of Tolerances

Condensed from "Mechanical Engineering"

Design tolerances for the manufacture of products should be determined from factual data analyzed statistically as to the characteristics required by the users and the characteristics of the manufacturing process. When it has been determined that the process can produce at a satisfactory cost a product that meets the user's requirements, the next step is to hold the process at the desired level.

The three requirements of inspection are: (1) The manufacturer must know that the process is dependable and that he is actually producing what he intends to produce. This requirement is met only by a statistically controlled process as evidenced by the use of quality control charts. (2) The manufacturer must know that the specifications are practical and profitable. (3) He must also know that the inspection procedure is adequate and that from his inspection records he can draw sound and correct conclusions about that part of his product which he does not inspect in order to be sure the first and second requirements are being met.

A 100% inspection is expensive, inefficient, and unnecessary. Sample tests are quite expensive and do not give much information, except to assure the quality level. All these objectionable features are avoided with practical certainty of a satisfactory product by using a control chart technique.

As long as the process is in "statistical control" at a satisfactory level, only a few samples are needed to assure satisfactory outgoing quality. Control charts simplify and economize inspection. If a process is turning out a product with only chance variations, then it is safe to depend upon a mere check test for inspection.

The problem is more complex in the case of an assembly of two or more parts. The purpose of the inspection is not to assure a perfect product but an acceptable one. In deciding on the sampling, the inspection must decide how to interpret the quality requirements of the specification and how to get the desired inspection results most economically.

If the process is continuous, long term average interpretation may be used; if it is intermittent, a lot by lot inspection is necessary. If the processes are in statistical control, the sample size and cost of inspection may be greatly reduced. Statistical methods offer almost the only scientific solution of the problem of inspection.

—W. B. Rice. *Mech. Engineering*, Vol. 67, Mar. 1945, pp. 168-170.

X-Ray Diffraction Study of Fatigue

Condensed from "Journal of Applied Physics"

To determine whether X-ray diffraction study of metals might indicate fatigue of the metal, or whether it would be possible to predict fatigue by X-ray diffraction studies, a series of tests was conducted with 14ST aluminum alloy. Diffraction pictures were taken after definite numbers of cycles in the fatigue testing machine.

Fatigue failures, it is indicated by experiment, begin with the rupture of some minute element, a stress concentration developing at the zone of failure, and causing successive failures spreading from this nucleus across the entire section. Failures occur suddenly, without any appreciable deformation, and the resulting fracture is coarsely crystalline.

It has been found that the diffraction patterns within the safe range of stress did not change from that of the unstressed material. However, when safe stresses were exceeded, changes in the number of reflection spots, blurring and elongation of the individual spots, and production of continuous lines occurred.

In aluminum alloy, the formation of sharp or nearly sharp spots corresponded with stresses below the yield point, while

Some oil well driller may never know the vital part that Magnaflux played in the rejection of these defective drill-pipe tool joints—any one of which might have caused a serious and expensive delay in the sinking of a well.

In signalling such causes of possible failure, Magnaflux guards the good name of the manufacturer and the good will of the user.

Because it is non-destructive, magnetic particle inspection makes it possible to check every part in the day's output—easily and rapidly to keep pace with production. Its clearly visible indications are inescapable—with the shape, location and size highlighted in finely divided magnetic particles.

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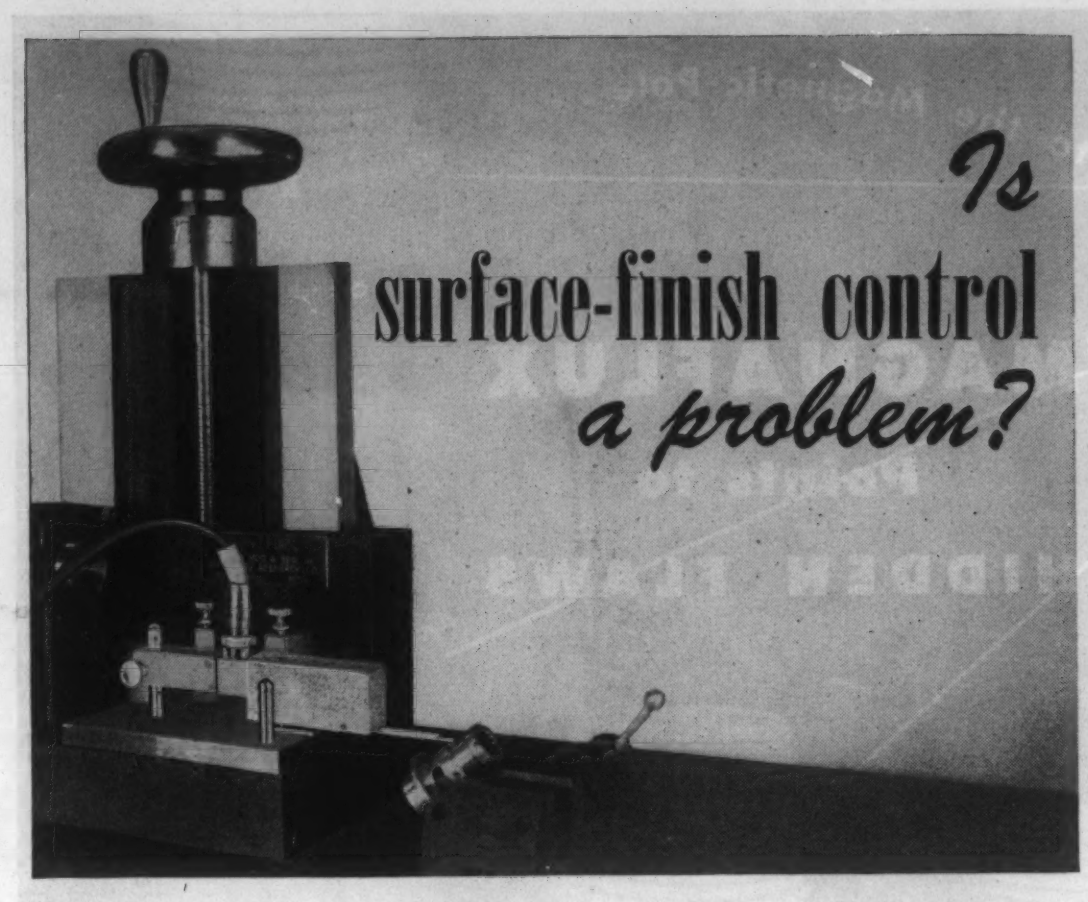

Is surface-finish control a problem?

WAR PRODUCTION experience has shown that the measurement of surface roughness is a practical necessity in any program of quality control. By enabling the practical measurement of surface roughness, the Profilometer has helped to round out this aspect of quality control in four ways:

1. It has enabled necessary research into the effect of surface roughness on the performance of parts.

2. It has enabled the use of a simple convenient symbol for the designation of the desired surface roughness on blueprints and specifications.

3. It has provided a quick and accurate means of checking production setups to determine the finish of parts coming from the machine.

4. It has enabled inspection departments to inspect quickly and accurately a run of parts for the surface roughness specified.

Military requirements for performance have resulted in surface roughness specifications being set for an infinite number of parts varying widely in their shapes, roughnesses, and materials. So that accurate measurements can be taken on this wide variety of parts, Physicists Research Company has developed a number of accessories for the standard Profilometer and maintains a program of continuing research and development in this field.

If you are now working on surface-roughness control or on post-war production plans, you will be interested in talking with one of our field engineers. Our representative would be glad to call at your plant to discuss the Profilometer and to demonstrate it on the work you are now doing. This demonstration call will incur no obligation on your part and may be arranged by addressing Physicists Research Company, 343 South Main Street, Ann Arbor, Michigan.

Pictured above: The Type KA Tracer and Type A Piloting Fixture for use on very smooth surfaces and for measuring the surface in holes and slots as small as 1 / 16 inch ID.

Profilometer Catalog available on request.

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those in which plastic deformation had multiplied and blurred the spots so as to form practically continuous rings were associated with stresses above the yield point.

Results obtained seem to show that, when failure occurred in areas outside those under observation, there is no great change in the diffraction pattern during the test. Spots remain clear and sharp, with no indication of fragmentation, distortion, or strain. When the fatigue crack formed inside the area under observation, spots become dull and indistinct, and tend to form continuous lines. This is especially noticeable during the last few thousands of cycles before failure.

Predicting failure by diffraction pattern changes, it was concluded, could be done only when the operator was fortunate enough to irradiate the field in which failure was to take place. The changes upon which the prediction would be based are limited, according to the tests made, to the last 300,000 to 20,000 cycles.

Since the changes take place in the last 300,000 cycles or less, and are detected only when the fatigue crack lies in the area irradiated, it was concluded that the changes were not caused by cold work owing to fatigue. Diffraction pattern changes are the effects of repeated cyclic stresses gradually weakening the intercrystalline bonds and causing the metal to fail.

—Arthur G. Barkow. *J. Applied Physics*, Vol. 16, Feb. 1945, pp. 111-120.

Progressive Inspection for Piston Rings

Condensed from "American Machinist"

Aircraft engine piston rings are made from individual ring castings of high quality alloy iron. These castings are turned, bored, and then finished in precision grinding and lapping machines to the tolerances for dimensional accuracy and surface finish demanded by the aircraft engine manufacturers. Most aircraft rings require many inspection operations (generally 100% of all specified dimensions), and all inspection benches have stations for some of the final finishing operations.

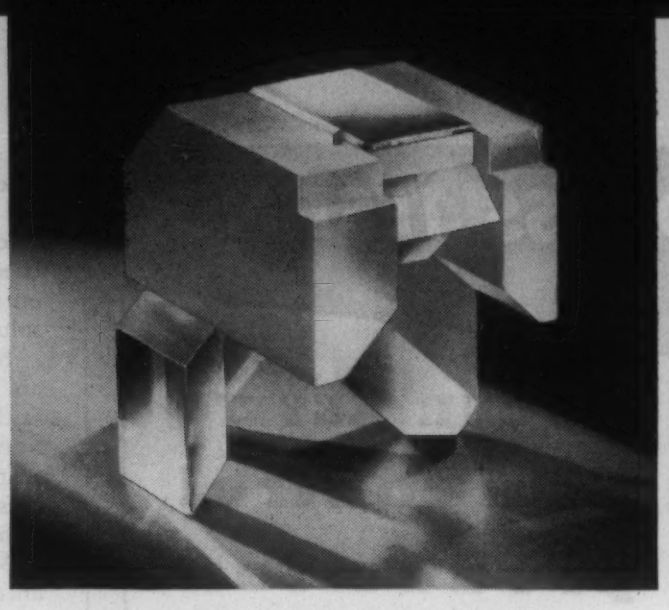
The first inspection operation is a visual check for foundry flaws and mechanical errors. Then every dimension and surface except width and end clearance are checked, and face light (to determine circularity when compressed) and load checks are made. There is a 100% check on the first 25 to 50 rings of a batch. If no errors are found, every twentieth ring is spot checked. If a bad ring is found in the first group, all rings in the batch must be gaged 100%.

At the next station the inside and outside diameters are deburred and radiused. The quality of the lapped surface is inspected visually. The following stations check end clearance, a face light inspection, width and thickness, circularity, and diametral load or weight required to close the ring to a specified gap size.

The inside-diameter corners are broken. Then a series of grooves across the face of one side of the gap are milled to provide

A seaman manning a 2½ meter Range Finder reports range continuously during action.—U. S. Navy Photo.

In testing, the Range Finders are filled with compressed gas and immersed in water to reveal leaks.



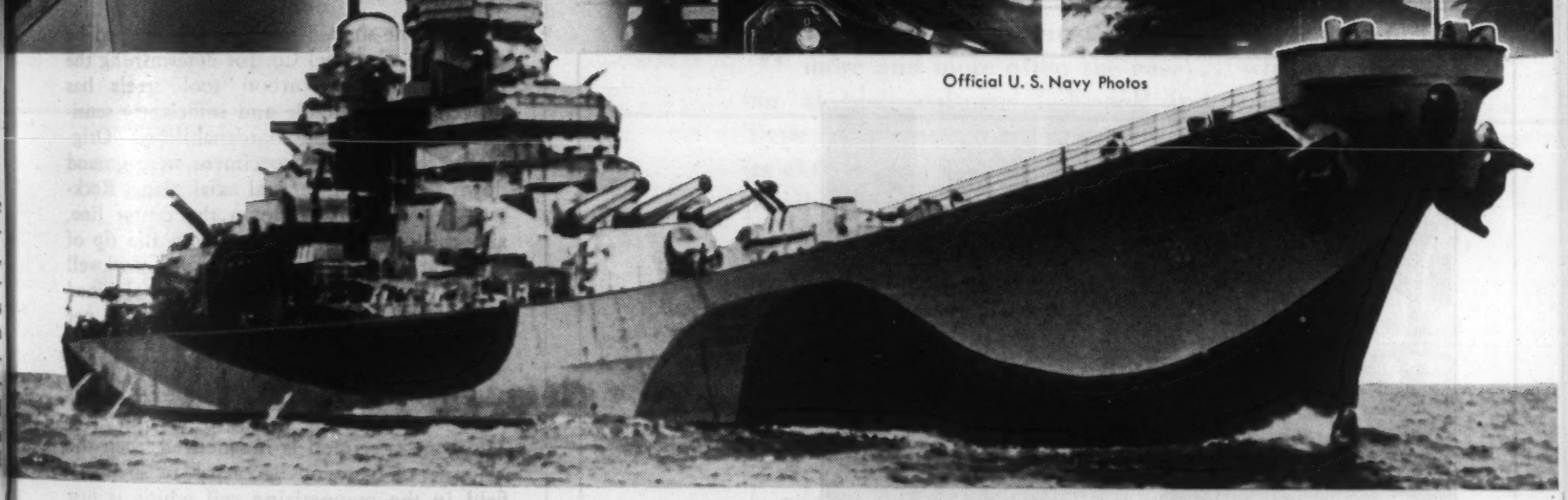
The coincidence prism shown here is the most complex of the precision optical parts in a Range Finder.

Giant Range Finders which span the battleship turrets represent two tons of precision optical instrument.

Test chamber duplicates the coutinuous vibration of the ship and the shock of a broadside of heavy guns.

Accurately aimed naval gunfire knocks out many enemy shore installations to make troop landings safer.

Official U. S. Navy Photos



The War's Toughest Optical Job

When the big guns of America's warships speak, the sea, the sky, and the earth tremble. Enemy shore installations and enemy ships, pinpointed by the accuracy of our gunfire, crumble even as the hopes of the aggressors have crumbled.

Creating and building the optical "eyes" that help to make possible this unerring accuracy is the war's toughest optical job. These eyes are the giant range finders which span each gun turret and fire control tower. They represent highly complex optical systems, so precise that the allowable deviation of some parts is but one-half second of arc, equivalent to 1″ at 6½ miles—systems so rugged that accuracy remains constant under the shock of thundering salvos and continuous ship vibrations.

The production of these giant optical instruments in the quantities needed by the world's greatest Navy is just one of the many tough optical jobs assigned to Bausch & Lomb . . . America's optical headquarters. Bausch & Lomb Optical Co., Rochester 2, New York.

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Particle hardness tests with this precise laboratory tool are now widely used to check specifications of single grains in alloys, plated surfaces, nitrided and cyanided layers, and pieces too small for other testers.

The Eberbach tester is equipped with a diamond indenter which permits measurement directly in units instantly convertible to other systems. Data may be taken visually or photographically.

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permanent identification of the manufacturer of the ring. For further identification, the type of ring is acid etched on one side. Then comes a final visual inspection, a recheck for width and end clearance, a check on the acid etching, a dip in rust preventive solution, and the wrapping and packing.

Some piston rings are Altinized, others are chromium plated for wear resistance. Such rings are first passed along the inspection bench for a preliminary check to insure that the parts are accurate. After plating, these rings are returned to the same inspection line.

Most aircraft engine rings have a tolerance of 10 to 12 micro-inches or even as fine as 6 micro-inches maximum for the quality of finish of the side surfaces. These rings usually are spot checked by sending them to an inspection laboratory where a surface analyzer is used to measure the roughness.

Rings rejected for any reason along the inspection benches are not scrapped but go to reinspection benches where a process control inspection group culls the good rings from the bad. Any rings at all questionable are culled out at the main inspection benches to avoid tying up the inspection line.

—D. M. Smith. *Am. Machinist*, Vol. 89, Apr. 12, 1945, pp. 114-117.

Magnetic Measurement of Hardenability

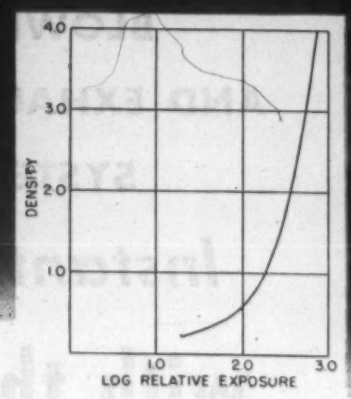
Condensed from "Metal Progress"

The cone-shaped test piece developed by the Carpenter Steel Co. for determining the hardenability of carbon tool steels has proved to be reliable and sufficiently sensitive to test shallow hardenabilities. Originally, the hardened specimens were ground down to the longitudinal axial plane, Rockwell readings made down the center line, and the distance measured from the tip of the cone to where the hardness was Rockwell C 55. From this value could be obtained the critical cooling velocity in deg. F. per sec. past 1300 F. to yield Rockwell C 55.

The grinding was found to be expensive and time consuming, so an electromagnetic equipment was designed to eliminate it. The cone specimen is magnetized, then the amount of current necessary to create a field in the magnetizing coil which is just sufficient to demagnetize the cone specimen is determined. This demagnetizing current (meter reading) is directly proportional to the coercive force.

With a constant carbon content and with the balance of the chemical composition within the limits ordinarily associated with such shallow hardening steels, the coercive force of the hardened cone specimens of various hardenabilities can be standardized against the critical cooling velocities.

Correlation curves between meter reading and critical cooling velocity are given for carbon contents of 0.70 to 1.20%. Of 159 heats checked by grinding down the cone specimens and comparing the critical cooling velocity as determined by the electromagnetic method and by Rockwell readings, 70.5% showed 0 to ±4% error, 23.9% showed ±4 to ±8% error, and 5.6% showed ±8 to ±10% error.

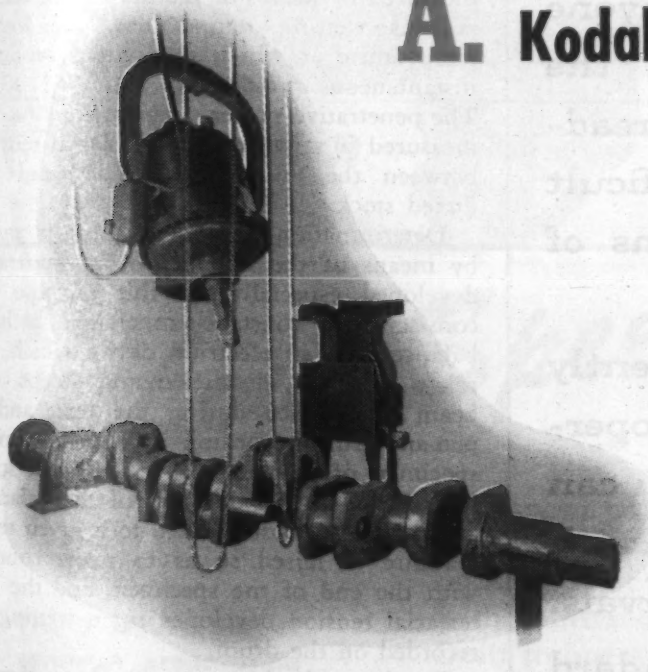


Characteristic Curve, Kodak Industrial X-ray Film, Type M, with direct x-ray exposure or with metallic screens.

Development: 8 minutes, at 68° F., in Kodalk X-ray Developér or Kodak Liquid X-ray Developer.

Q. Which x-ray film is first choice for most critical inspection of steel castings at high kilovoltages?

A. Kodak's Type M



WHEN inspection must be highly critical (which is more and more often the case)... when you're working at high voltages... Kodak Industrial X-ray Film, Type M, is specifically *right*. Used with lead foil screens, its extra fine grain and highest available contrast make possible radiographs of outstanding quality, distinguished by unusually fine detail. Eastman Kodak Company, X-ray Division, Rochester 4, N. Y.

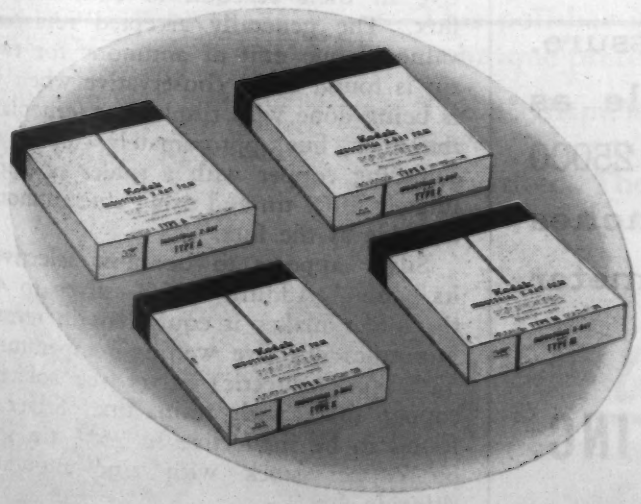
Kodak makes the four types of film needed in industrial radiography

In addition to Type M, Kodak supplies:

Kodak Industrial X-ray Film, Type K . . . for gamma and x-ray radiography of heavy steel parts, or of lighter parts at low x-ray voltages where high film speed is required.

Kodak Industrial X-ray Film, Type A . . . most often used for light alloys at lower voltages and for million-volt radiography of thick steel and heavy alloy parts.

Kodak Industrial X-ray Film, Type F . . . primarily for radiography, with calcium tungstate screens, of heavy steel parts. The fastest possible radiographic method.



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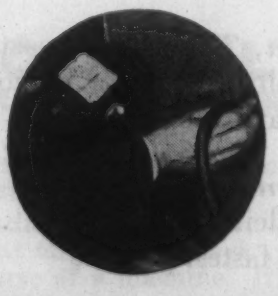
with the Alnor Velometer

This instantaneous direct reading air velocity meter measures air speed in feet per minute. There are no calculations, no timing, no conversion tables; its use is so simple that anyone can take accurate measurements with the Velometer. Extension jets permit correct readings in many locations that would be difficult or impossible to reach with other means of measurement.

Keep exhaust equipment working efficiently by regular checks for draft, leaks, blower operations, etc., with the Alnor Velometer. You can get accurate information on performance with a few minutes' inspection at regular intervals.

The Velometer is made in several standard ranges from 20 fpm to 6000 fpm and up to 3 inches static or total pressure. Special ranges available as low as 10 fpm and up to 25000 fpm velocity and 20 inches pressure. Write for Velometer bulletins.

Velometer used for positive static pressure readings



ILLINOIS TESTING LABORATORIES, INC.
420 North La Salle Street
Chicago 10, Illinois

Tests with flat end Jominy test pieces 7/8 in. in diam. by 3 in. long of an oil hardening tool steel (0.9 C, 1.75% Mn) showed a straight line correlation between the meter reading by the electromagnetic method and the critical cooling velocity for Rockwell C 55 as determined from Rockwell readings on ground flat surfaces on the Jominy specimen. Therefore, the instrument would be useful to those primarily concerned with Jominy hardenability testing as well as to those dealing with shallow hardening carbon tool steels.

—C. B. Post & W. H. Fenstermacher. *Metal Progress*, Vol. 47, Feb. 1945, pp. 286-288.

Soft Solders

Condensed from "Journal of the Institute of Metals"

With changes of composition of the soft solders due to the tin shortage, a test method to evaluate joint-forming characteristics became necessary. The spreading-drop test does not always give results in accordance with practice. Studies of the soldering operations indicate that solder-flux-stock should be considered as a system, rather than determining values for solder compositions alone.

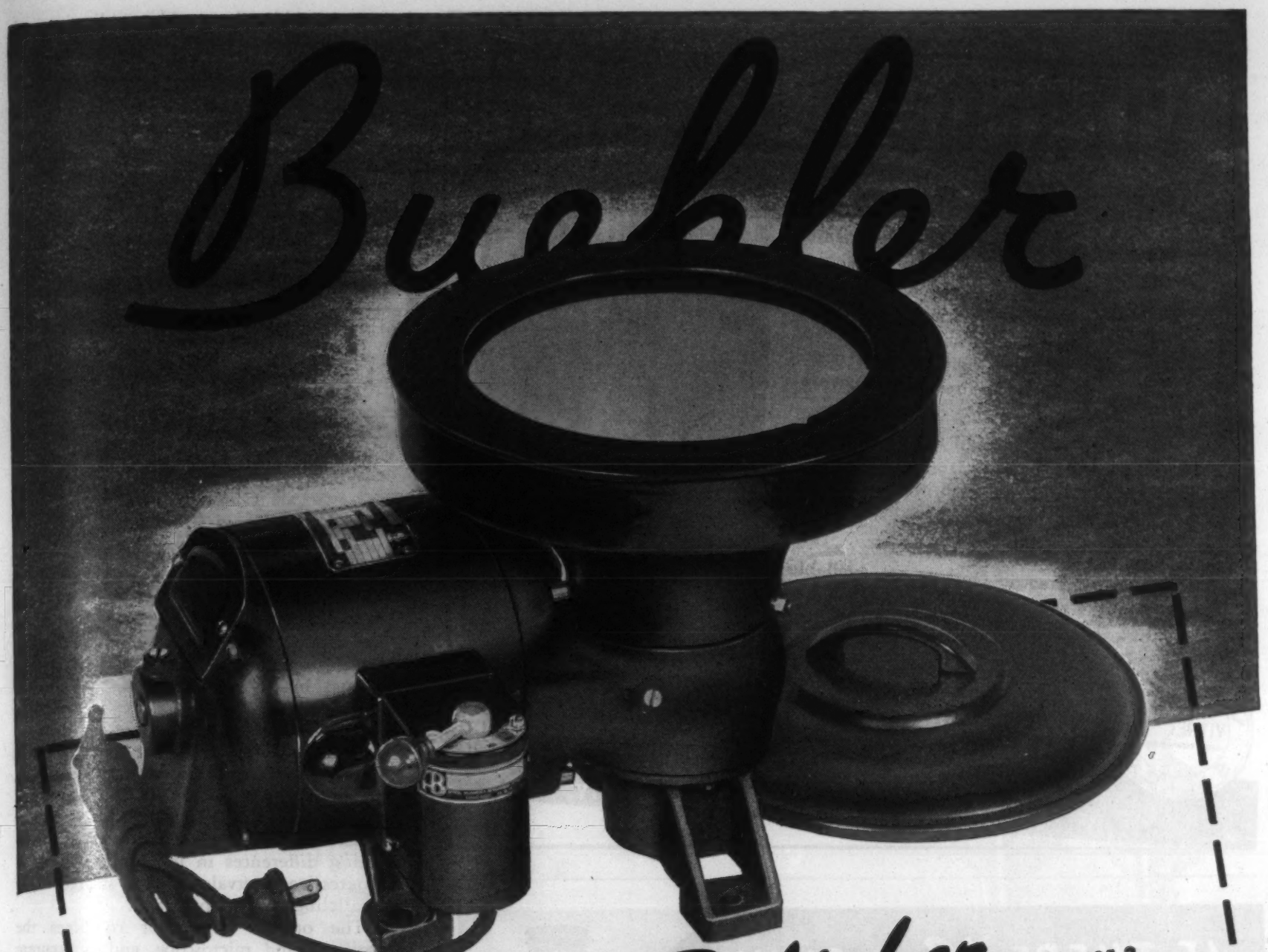
Ease of soldering may be quantitatively measured by means of the minimum instantaneous wetting temperature, the lowest temperature at which the system produces instantaneous wetting (within 0.2 sec.). The penetrative power of the system may be measured in terms of the interfacial tension between the flux-covered solder and the fluxed stock.

Determination of these values is made by means of the kollagraph, an apparatus developed especially for this purpose. It consists of a constant-temperature bath, a balance with an electrical device which, by relays and an electric motor, keeps the beam in balance during the test, and a pen-and-drum recording device. A fluxed specimen of the stock about 7.5 cm. long is suspended from one arm of the balance, a bath of the solder heated to a given temperature is raised so as to make contact with the end of the specimen, and the interfacial tension developed upon wetting is recorded on the drum.

Results with this apparatus have shown that the different types of solder are selective in their reaction to both stock and flux. The generally accepted replacement value of one unit of antimony for two of tin is found to be conservative when work is being done with tinplate or terneplate as the stock, but approximately correct when soldering copper with a solder of approximately 40% tin and using zinc ammonium chloride as the flux.

Silver appears to be most selective in its action. Adding 0.85% silver to 40% tin solder makes it equivalent in terms of minimum effective wetting temperature to 63% tin (eutectic) silver-free solder on copper stock with resin flux. Silver was found to be ineffective in 25% tin solder on copper stock with zinc ammonium chloride flux.

It is evident that the effective use of the silver-bearing solders is limited. Anti-



Low Speed Polisher No. 1505-2

. . for accurate final polishing

Low speed polishing is increasingly popular for the final step, particularly where soft non-ferrous metals are encountered. The production of smooth polished samples with a minimum of surface scratches and disturbed metal is the outstanding feature of this low speed Buehler Polisher No. 1505-2. Built to operate at selective speeds of 150 r.p.m. and 250 r.p.m. through a positive gear head drive housed in an oiltight base, this polisher represents the highest development in equipment for precision finishing of specimens. This polisher is also perfectly suited to the wax lap or lead lap polishing technique preferred by many metallurgists.

The 8" diameter polishing disc is attached to a countershaft by a tapered sleeve. This tapered fit and long span between bearings assures smooth operation. The motor is ¼ h.p. single phase ball bearing, operating on 110 V., 60 Cycle AC current. Shipping weight, 80 lbs.

THE BUEHLER line of specimen preparation equipment includes —

CUT-OFF MACHINES • SPECIMEN MOUNT PRESSES • POWER GRINDERS • EMERY PAPER GRINDERS • HAND GRINDERS • BELT SURFACERS • POLISHERS • POLISHING CLOTHS AND ABRASIVES

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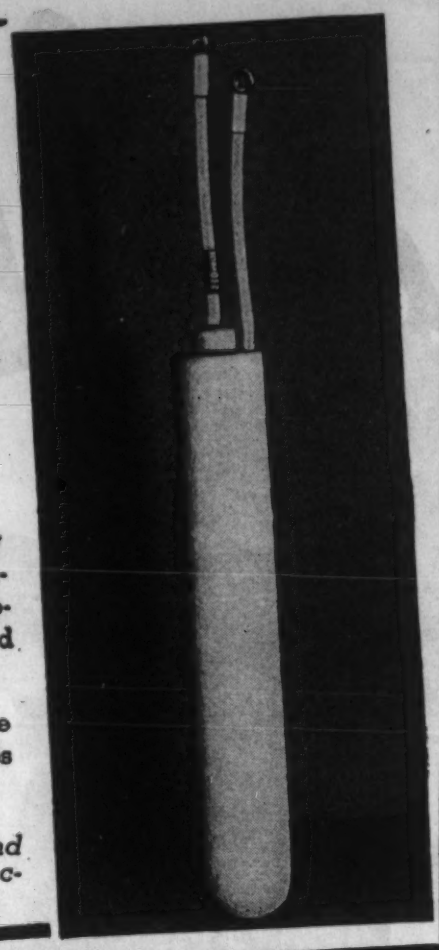
METALLURGICAL APPARATUS

165 West Wacker Drive, Chicago 1, Illinois

VITREOSIL
IMMERSION HEATERS



Vitreosil Electric Immersion Heaters are of particular value in many instances where liquids of an acid reaction must be heated. For such applications, the Vitreosil envelope of the heating unit combines the advantages of being acid-proof, a good electrical insulator, and resistant to severe thermal shock.

Vitreosil (99.8% SiO_2) is unaffected by all halogens and acids, regardless of temperature or concentration, with the exception of fluorine and hydrofluoric and phosphoric acids.

Vitreosil Electric Heaters are available in lengths ranging from 10 to 30 inches with k.w. ratings of .25 to 5.0.

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Manufacturers — ELIZABETH, N. J.

monial solders have wider application, only zinc being barred specifically. The solders of widest applicability were the lead-tin solders with tin content above 40%. Tinplate, terneplate, blackplate, zinc and brass showed little distinction with this last type.

While hot-shortness, creep strength, and resistance to fatigue may limit the choice of solders in certain cases, joint-forming capacity remains the fundamental characteristic, for joints fail more often under mechanical stresses because they are defective than for any other reason.

—L. G. Earle. *J. Inst. Metals*, Vol. 71, Feb. 1945, pp. 45-72.

Optical Inspection

Condensed from "Production Engineering and Management"

Mass production of precision parts has proved that many manual inspection methods, satisfactory in the past, are inadequate today. The tool and process engineer, who has demanded faster, more efficient methods for gaging finished work, has been instrumental in developing the optical method of inspection.

To check the squareness of each groove sidewall to a close angular tolerance, past practices required the use of a straight edge, dial indicator, surface plate, shim stock and considerable effort. The inspector attempted to ascertain the slope of the groove wall by noting differences in indicator readings at progressive intervals along a straight edge paralleling the groove wall.

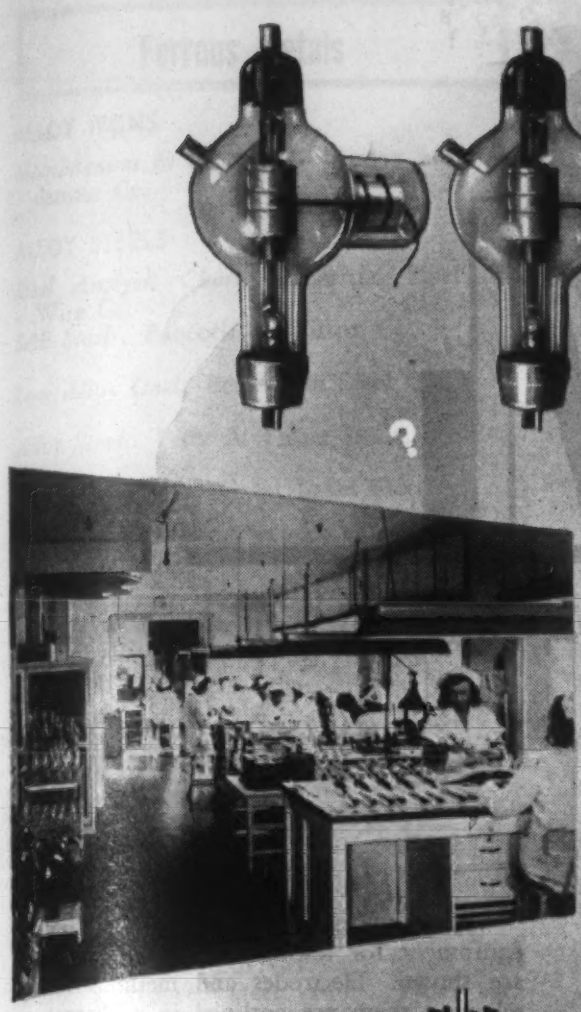
The optical comparator combines the projector and microscope, and is accurate enough for exacting laboratory tests yet simple enough for any competent workman without special training. It consists of an optical system, means to hold the work, and necessary adjustments for making measurements. Optical comparators are used to check threaded sections, tool profiles and profiles of simple and complex production parts.

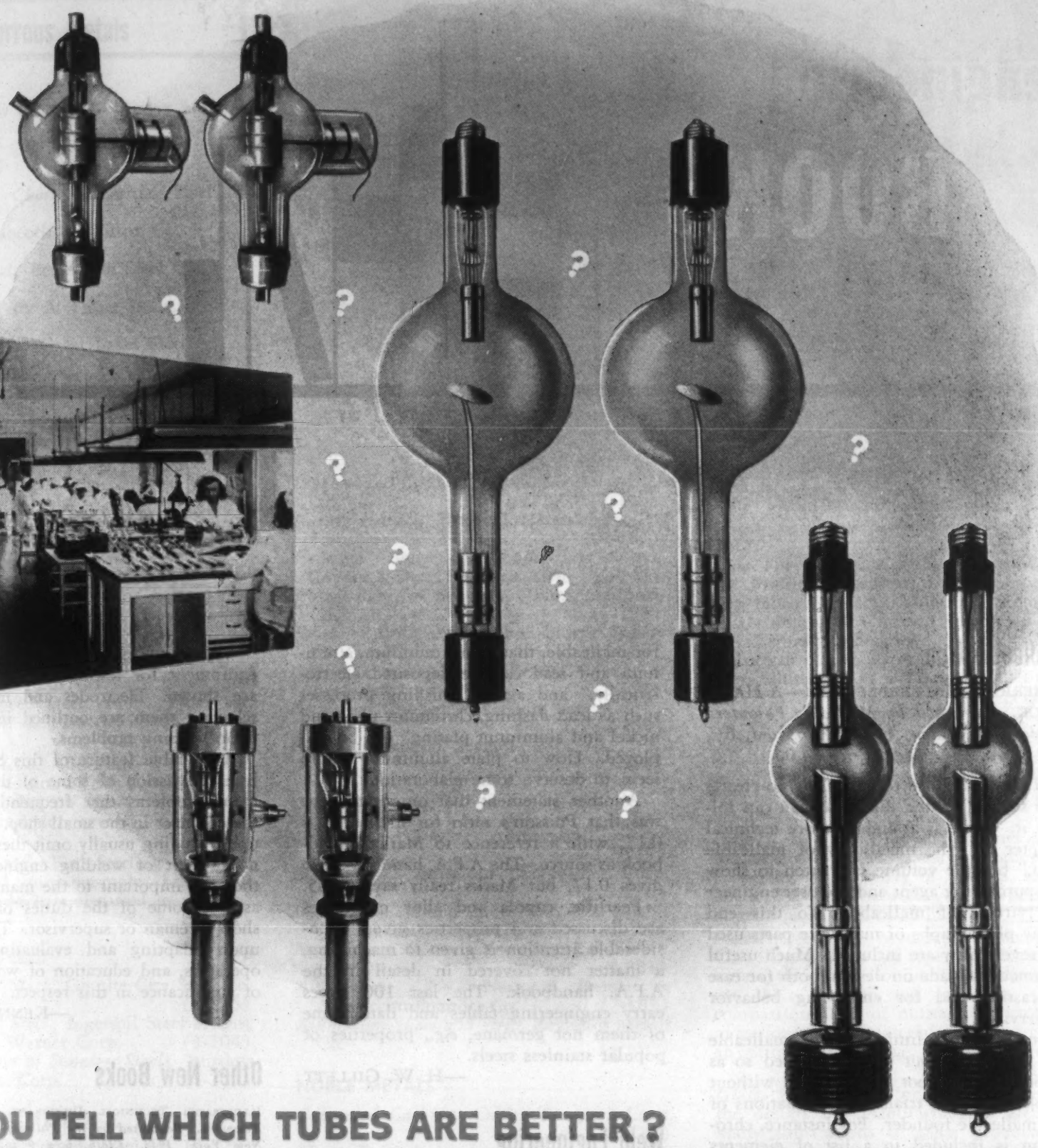
The optical system contains a light source in the lamp house, such as a 50-candlepower automobile headlamp, operating off a 6-v. transformer. Suitable condenser lens concentrate a beam of parallel light rays across the work piece. A compound set of lenses consisting of objective and eyepiece lenses give this instrument a magnifying power of 31.25 X. An aluminum oxide-coated mirror reflects the magnified image upon a ground glass screen.

Mechanical adjustments permit the workpiece to be moved in the field of parallel rays of light vertically, horizontally and angularly in the horizontal plane. A table adjustment focuses the workpiece. Angles in the vertical plane are measured directly on the ground glass screen by rotating the screen by vernier control, with angles measured to within $\pm 1'$ accuracy.

For every ¼-in. of work area projected, the screen image portrays about 8 in. of area. The accurately and greatly magnified image lends itself to extremely close adjustment of the indicating bands of reflected light.

—G. C. Brown. *Prod. Engineering & Management*, Vol. 15, Feb. 1945, pp. 87-90.

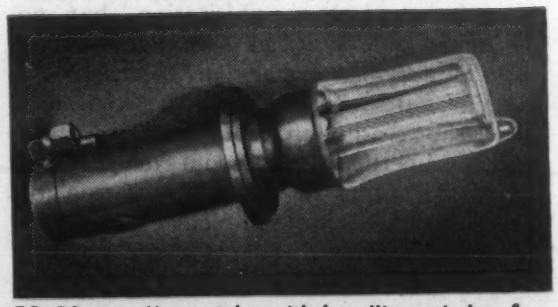




CAN YOU TELL WHICH TUBES ARE BETTER?

Two tubes of the same type may look exactly alike, but if one was assembled in the Machlett "White Room" while the other was put together under average factory conditions, there would be a considerable difference between them. In lighting, cleanliness and conditioned environment, the "White Room" resembles a hospital operating room, and tubes passing through it remain free of internal contamination that would lessen their stability, shorten their life. Such tubes will give full-rated, predictable performance, and prove uniformly economical and satisfactory. It was to achieve such improved results that Machlett built the first "White Room" in the industry — subsequently adopted by others. Many still newer Machlett techniques, such as this, continue to improve the quality and performance of our products. In this way, Machlett leadership in the electron tube field is maintained.

When you need a medical or industrial X-ray tube, or an oscillator, amplifier, or rectifier for radio or industrial purposes, select a Machlett. It will pay you in stability of operation and long life. For information as to available tubes, write Machlett Laboratories, Inc., Springdale, Connecticut.



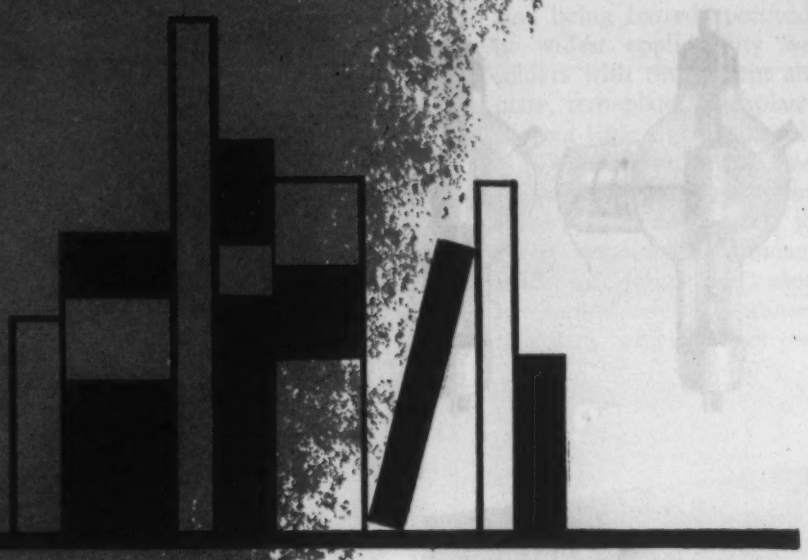
EG-50—an X-ray tube with beryllium window for radiography of light materials and thin sections.

MACHLETT

X RAY TUBES SINCE 1897

TODAY THEIR LARGEST MAKER

engineering BOOKS



Malleable Iron

AMERICAN MALLEABLE IRON—A HANDBOOK. *Published by Malleable Founders' Society, Cleveland, 1944. Fabrikoid, 6¼ x 9¼ in., 367 pages. Price $4.00.*

This is intended to be, and is, so clearly and simply written that a layman can follow it. There is a slightly more technical chapter on "the metallurgy of malleable iron," but the volume is written to show the purchasing agent and the user engineer the virtues of malleable. To this end many photographs of malleable parts used for severe duty are included. Much useful comment is made on design, both for ease of casting and for enhancing behavior in service.

Some of the limitations of malleable are mentioned, but always phrased so as to put the best foot forward, and without emphasizing the trials and tribulations of the malleable founder. For instance, chromium is included in a list of elements interfering with graphitization, but no stress is laid on it, as it is the worry of the foundryman rather than the user.

The statement is made that "malleable iron shows no appreciable decrease in impact properties from room temperature down to minus 40 F.", which is true for standard malleable completely devoid of pearlite remnants, but not true of all commercial malleable meeting regular specifications.

Because such things are slurred over, this handbook contains little of value to the malleable founder not already at his disposal in the A.F.A. Cast Metals Handbook. It is, however, somewhat more glamorous propaganda, though not so obviously so that the user-reader is likely to react that "the lady doth protest too much." The history of the malleable industry is quite fully given, and in a form to interest the general reader.

The statement is made, under coatings for malleable, that "zinc, cadmium, aluminum and lead can be deposited electrolytically," and again "finishing processes such as lead flashing, chromium plate and nickel and aluminum plating" can be employed. How to plate aluminum would seem to deserve some elaboration.

Another statement that caught the eye was that Poisson's ratio for malleable is 0.17, with a reference to Marks' Handbook as source. The A.F.A. handbook also gives 0.17, but Marks really says 0.265.

Pearlitic, cupola and alloy malleables are discussed and properties given. Considerable attention is given to machining, a matter not covered in detail in the A.F.A. handbook. The last 100 pages carry engineering tables and data, some of them not germane, *e.g.*, properties of popular stainless steels.

—H. W. GILLETT

Weld Engineering

ARC WELDING ENGINEERING AND PRODUCTION CONTROL. *By Walter J. Brooking. Published by McGraw-Hill Book Co., Inc., New York, 1944. Cloth, 5½ x 8½ in., 347 pages. Price $4.00.*

Many books have been written dealing with the subject of arc welding, but few have been prepared with the needs of the welding engineer, responsible for plant production, clearly in mind. Mr. Brooking has done that. His book will be an excellent guide for the engineer who must not only design weldments, but must oversee or plan for their actual fabrication in the modern weld shop.

There are sections discussing materials and equipment, flame cutting of parts for weldments, fit-up, jigs and fixtures, inspection and machining, and final cleaning. The training of operators, specifications, and engineering control methods are also taken up.

Typical charts from automatic recording equipment for testing welding machines are shown. Electrodes and methods for selecting them are outlined in a chapter upon welding problems.

A valuable feature of this book is the brief discussion of some of the management problems that frequently confront the engineer in the small shop. Textbooks upon welding usually omit these topics as not a part of welding engineering, but they are important to the man who must assume some of the duties of the weld shop foreman or supervisor. The sections upon adapting and evaluating welding operators, and education of workmen are of significance in this respect.

—KENNETH ROSE

Other New Books

ILLUSTRATED TECHNICAL DICTIONARY. *By Maxim Newmark. Published by the Philosophical Library, New York, 1944. Cloth, 6 x 9 in., 352 pages. Price $5.00.* The plan of this dictionary is to supply a representative and wide selection of officially approved standard definitions promulgated by various United States engineering, technical, trade and industrial organizations, and by Government agencies. As to subject coverage, the following general principle has been observed in selecting, editing and compiling the material: The number of terms included for any single subject were determined on the basis of whether that subject is fundamental in all fields and whether it has current importance in the world of technology. There are some 90 illustrations.

1944 SAE HANDBOOK. *Published by Society of Automotive Engineers, New York, 1944. Cloth, 6 x 8½ in., 804 pages. Price $5.00.* Wartime industrial and technical progress in developing new methods and materials facilitating war production are reflected in this handbook. Among the new features are: specifications for medium- and heavy-duty coolant hoses; detailed standards for straight and taper pipe threads; and nomenclature for pistons and piston-rings. Revised data include: tables on steel hardness conversion numbers; and specifications for non-ferrous metals, including solders, and both cast and wrought aluminum, magnesium, brasses, bronzes, and bearing and bushing alloys.

Manufacturers' Literature

Ferrous Metals

ALLOY IRONS

Molybdenum in Cast Iron. Climax Molybdenum Co. (1-295)

ALLOY STEELS

Steel Analysis Chart. American Steel & Wire Co. (1-218)
SAE Steels. Babcock & Wilcox Co. (1-144)
Low Alloy Steel. Bethlehem Steel Co. (1-117)
Alloy Steels. Peter A. Frasse & Co., Inc. (1-220)
Low Alloy Steels. Great Lakes Steel Corp. (1-171)
High Strength Steel. Inland Steel Co. (1-90)
Molybdenum Wrought Steels. Molybdenum Corp. of America. (1-139)
Aircraft Alloy Steels. Joseph T. Ryerson & Son, Inc. (1-210)

CARBON STEELS

Cold Drawn Bar Steels. Bliss & Laughlin, Inc. (1-282)
Steel. Youngstown Sheet & Tube Co. (1-227)

HIGH SPEED STEELS

High-Speed Steel. H. Boker & Co., Inc. This 4-page bulletin discusses Novo Superior high-speed steel, 18-4-1 type, for use in punches, dies, cutters, hobs, reamers, etc. (1-302)
High-Speed Steels. Cleveland Twist Drill Co. The fifth edition of this handbook presents complete data on Mo-Max high-speed steels, and includes several informative charts. (1-300)
High-Speed Steel. Firth-Sterling Steel Co. An improved tungsten-moly high-speed steel, Star Mo M-2, is discussed in a 4-page folder. (1-301)

STAINLESS STEELS

Stainless Clad Steel. Granite City Steel Co. (1-256)
Stainless Clad Steel. Ingersoll Steel & Disc Div., Borg Warner Corp. (1-104)
Heat Treatment of Stainless Steels. Rustless Iron & Steel Corp. (1-279)

TOOL AND DIE STEELS

Tool Steels. Copperweld Steel Co. (1-228)
Hot Work Tool Steels. Crucible Steel Co. of America. (1-289)
High-Speed Tool Steel. General Aircraft Equipment, Inc., Tool Div. (1-288)
Tool Steels. Jessop Steel Co. (1-278)
Die Steels. Latrobe Electric Steel Co. (1-149)
Flat Ground Stock. Simonds Saw & Steel Co. (1-212)

IRON AND STEELS—GENERAL

Surface-Treated Sheet Steel. American Rolling Mill Co. (1-286)
Furnace-Treated Bar Steels. La Salle Steel Co. (1-299)
Steel Specialties. A. R. Purdy Co., Inc. (1-213)

Non-Ferrous Metals

COPPER AND ITS ALLOYS

Copper and Its Alloys in Tubes and Plates. American Brass Co. (2-164)
Oxygen-Free Copper. American Metal Co., Ltd. (2-145)
Bearing Bronze. Bearium Metals Corp. (2-287)
Wrought Copper and Copper-Base Alloys. Copper & Brass Research Assn. (2-245)
Bronze Bars for Bearings. Johnson Bronze Co. (2-198)
Phosphor Bronze. Phosphor Bronze Smelting Co. (2-100)
Copper and Its Alloys. Revere Copper & Brass, Inc. (2-199)
Beryllium Copper. Riverside Metal Co. (2-259)
Phosphor Bronze. Seymour Mfg. Co. (2-285)

LIGHT METALS

Magnesium Alloys. Aluminum Co. of America. (2-215)
Magnesium. American Magnesium Corp. (2-230)
Ingot Metal. Bohn Aluminum Co., Michigan Smelting & Refining Div. (2-204)
Magnesium Alloys. Dow Chemical Co. (2-281)
Aluminum Alloy. National Bronze & Aluminum Foundry Co. (2-187)
Aluminum Sheet and Strip. Reynolds Metals Co. (2-268)

NOBLE METALS

Cemented Carbide. Callite Tungsten Corp. (2-212)
"Foote-Prints"—a house organ on rare metals, alloys and ores. Foote Mineral Co. (2-267)
Metal Hydrides—Powders or Ingots. Metal Hydrides, Inc. (2-96)
Metal Powders. Powder Metals & Alloys, Inc. (2-149)
Hard Facing Alloys. Wall-Colmonoy Corp. (2-251)

SPECIAL METALS

Columbium. Fansteel Metallurgical Corp. Complete information on columbium, including numerous tables on wire, sheet and rod data, is presented in a 12-page booklet. (2-289)

OTHER METALS

Non-Ferrous Test Bars. American Smelting & Refining Co., Federated Metals Div. (2-261)

Please Use the Coupon on Page 1751

Non-Metallic Materials

Glass Fabrication. Corning Glass Works. The Multiform process, a new method of glass fabrication applicable to a number of glass compositions having widely different characteristics, is described, and Pyrex-brand Multiform glassware produced by this process is illustrated in a 12-page bulletin. (12-15)
Varnishes and Resins. Dow Corning Corp. A variety of electrical insulating silicone varnishes and resins for use with inorganic spacing materials are discussed in a 4-page folder. Specifications and physical properties are included. (12-13)
Plastics. E. I. du Pont de Nemours & Co., Inc. A digest of the forms, applications and properties of a variety of plastics, such as Lucite, Pryalin, Plastacelle, etc., is presented in an 8-page, illustrated bulletin. (12-14)
Plastics. Eclipse Moulded Products Co. Complete data on all types of plastics materials, their behavior in the molding process, their strength and weakness, plus a comparison chart of outstanding properties of various plastic materials, are presented in an attractive, 48-page, illustrated catalog. (12-16)
Glass. Kopp Glass, Inc. Complete data on the design and manufacture of glass, and many illustrations of glass products produced by this company, are presented in an attractive, 24-page bulletin. (12-17)
Plastic Laminate. Continental Can Co. (12-8)
Non-Metallic Materials. Continental-Diamond Fibre Co. (12-7)
Plastics. Dow Chemical Co., Plastics Div. (12-4)
Plastic Data Book. Formica Insulation Co. (12-11)
Plastics and Its Equipment. Hydraulic Press Mfg. Co. (12-10)
Injection Molding Machine for Plastics. Lester-Phoenix, Inc. (12-9)

Engineering Design

ALLOY CASTINGS

Heat- and Corrosion-Resistant Castings. Alloy Casting Co. (3-497)
Heat Resisting Steel Castings. Chicago Steel Foundry Co. (3-263)

Corrosive Handling Equipment. Duraloy Co. (3-183)
X-Ray Tested Castings. Electro Alloys Co. (3-74)
Alloy Steel Castings Reference Chart. Lebanon Steel Foundry. (3-526)
Heat and Corrosion-Resisting Castings. Sterling Alloys, Inc. (3-513)

CASTINGS—IRON, STEEL, NON-FERROUS, ETC.

Malleable Castings. Lancaster Malleables & Steel Corp. The facilities of this malleable casting producer are described and illustrated in an 8-page bulletin. (3-571)
Steel Castings. Steel Founders' Soc. of America. Complete data on the steel castings industry, including the machining, heat-treating, testing and inspection cleaning and finishing, etc. of these castings, are presented in an attractive, 64-page, illustrated catalog. (3-569)
Heat Treated Aluminum Castings. Acme Aluminum Alloys, Inc. (3-290)
Special Castings. Advance Foundry Co. (3-381)
Beryllium Copper Castings. Akron Bronze & Aluminum Co. (3-556)
Castings, Forgings, Etc. American Brake Shoe Co. (3-499)
Manganese Steel in the Steel Industry. American Manganese Steel Div., Am. Brake Shoe Co. (3-275)
High-Strength Metal. Diamond Iron Works, Inc. (3-452)
Stainless Steel Castings. Duriron Co., Inc. (3-202)
Non-Ferrous Sand Castings. Eclipse-Pioneer Div., Bendix Aviation Corp. (3-490)
Data on Brass and Bronze Castings. Hammond Brass Works. (3-194)
Non-Ferrous Castings. Howard Foundry Co. (3-333)
Castings. Meehanite Research Institute. (3-561)
Alloy Castings. Michiana Products Corp. (3-512)
Cast Steel Breech Rings. Ohio Steel Foundry Co. (3-447)
Centrifugally Cast Non-Ferrous Metals. Shenango-Penn Mold Co. (3-339)

DIE CASTINGS, PRECISION CASTINGS, ETC.

Designing for Die Casting. New Jersey Zinc Co. (3-550)
Die Castings. New Products Corp. (3-468)
Die Castings. Pryor Mfg. Co. (3-551)

FORGINGS

Metal Forgings. Scovill Mfg. Co. This bulletin discusses a variety of metal forgings applications, such as couplings for fuel oil and gasoline hose, valves, torch heads and regulators for compressed gas cylinders, etc. (3-567)
Drop Forgings. Drop Forging Assn. (3-174)
Pressed and Forged Products. Lenape Hydraulic Pressing & Forging Co. (3-211)
Steel Forgings. Transue & Williams Steel Forging Co. (3-383)

METAL PARTS

Oil-Retaining Bearings. Bound Brook Oil-Less Bearing Co. A complete list of sizes of both Compo oil-retaining porous bronze bearings and Powdiron oil-retaining sintered iron bearings is presented in a 20-page, illustrated bulletin, No. 20. (3-564)
Safety Clamps. B. F. Goodrich Co. Two types of Punch-Lok safety clamps—preformed complete rings for slipping over the ends of hose, nipples, etc., and open-end straight bands for curving around cable, hose, etc.—used for banding hose or splicing cable are described and illustrated in a 4-page bulletin. (3-566)
Steel Fabrication. Stacey Bros. Gas Construction Co. Complete data on the fabrication of special tanks or vessels of aluminum, steel or its alloys in welded, riveted or bolted construction in any size and shape are presented in a 44-page, illustrated bulletin, No. G-45. (3-568)
Corrosion-Resistant Chain. Youngstown Welding & Engineering Co. Complete data on Weldco chain, a corrosion-resistant chain made of Monel, Inconel, nickel and stainless steel, are presented in a 4-page bulletin. No. C145. Specifications are included. (3-570)
Ball and Roller Bearing Specifications. Anti-Friction Bearing Manufacturers Assn. (3-548)
Flexible Tubing and Bellows. Chicago Metal Hose Corp. (3-377)
Electrical Contacts. Gibson Electric Co. (3-76)
Magnet Manufacture. Indiana Steel Products Co. (3-359)
Brush Springs. Instrument Specialties Co., Inc. (3-451)
Sheet Metal Parts. Kirk & Blum Mfg. Co. (3-238)
Spring Steels. Lee Spring Co., Inc. (3-544)
Wear Resistant Precious Metal Parts. Permo, Inc. (3-65)
Steel, Bronze, Etc. Precision Balls. Vulcanite Portland Cement Co. (3-547)
Screw Products. Wisconsin Screw Co. (3-546)
Steel Stampings. Worcester Pressed Steel Co. (3-555)

NON-METALLICS

Felt Cut Parts. Felters Co. This 3-page folder describes felt cut parts, and illustrates how they keep oil in and dirt out of bearings, keeps joints tight, etc. (3-565)
Plastics in Product Design. Durez Plastics & Chemicals, Inc. (3-93)
Plastic Custom Molding. Imperial Molded Products Corp. (3-389)
Molded Plastic Products. Plastic Manufacturers, Inc. (3-430)
Plastics. Richardson Co. (3-403)
Liquid Plastic. U. S. Stoneware Co. (3-503)
Laminated Plastic. Westinghouse Electric Corp. (3-562)

POWDER METALLURGY

(See also Sec. 2—Special Metals; Sec. 3—Metal Parts; and Sec. 8—Metal Powder Processing)

Powdered Metal Parts. Keystone Carbon Co. (3-412)
Powder Metallurgy Parts. Moraine Products Div., General Motors Corp. (3-139)
Powder Metallurgy Products. Powder Metallurgy Corp., Div. General Bronze Co. (3-89)

TUBING

Boiler Tubes. Bissett Steel Co. (3-553)
Fabricated Tube Parts. Calumet & Hecla Consolidated Copper Co., Wolverine Tube Div. (3-531)
Piping. Flori Pipe Co. (3-345)
Electric Welded Tubing. Formed Steel Tube Inst. (3-543)
Steel Tubing Bursting Pressure Chart. Globe Steel Tubes Co. (3-493)
Brass Fitting and Tubing. Imperial Brass Mfg. Co. (3-149)
Plywood Tubing. Plymold Corp. (3-524)
Square Steel Tubing. Summerill Tubing Co. (3-399)
History of Piping. Tube Turns, Inc. (3-303)

OTHER METAL FORMS

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Steel Hardening Compound. Necamp Metallurgical Laboratories. This six-page, pocket-size, illustrated folder describes Hi-Speed-It, a steel hardening compound used in the airplane, shipbuilding, railroad and maintenance industries. (5-619)
Metal Treating. American Cyanamid & Chemical Corp. (5-604)
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Industrial Burners. Dempsey Industrial Furnace Corp. Low-pressure, fuel oil industrial burners, suitable for both heavy and light oil, are described and illustrated in an 8-page bulletin, No. 1. (5-622)
Hot Air Burners. Bloom Engineering Co. (5-563)
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Electronic Heater. Allis-Chalmers Mfg. Co. Bulletin No. B-6372, four pages, describes and illustrates an electronic heater for induction and dielectric heating. (5-616)
Induction Heat Treating. Budd Induction Heating, Inc. Complete data on the use of Budd induction heat treating for hardening the inside surfaces of cylindrical shapes through electrically-induced heat are presented in a 12-page, illustrated bulletin. (5-617)
Induction Generators. Induction Heating Corp. A special set of two Model 1070 thermonic induction generators, which can be operated separately or interconnected when 2200 B.t.u.'s per min. are required, are described and illustrated in a single sheet. (5-618)
Electronic Heaters. Federal Electric Co., Inc. (5-593)
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Wire and Strip Mill Furnaces. W. S. Rockwell Co. Bulletin No. 418, eight pages, profusely illustrates and describes a variety of gas, oil and electric wire and strip mill furnaces, batch loading or continuous types, for annealing, galvanizing, hardening, etc. (5-620)
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Refractories • Insulation

Refractories, Etc. Carborundum Co., Refractory Div. The history and development of this company, and brief descriptions of its many products, such as super-refractories, MX wheels, coated abrasives, etc., is presented in an attractive, 24-page bulletin. (6-186)
Fire Brick. Harbison-Walker Refractories Co. Five types of insulating fire brick, typical applications, and complete thermal data in table form are described in a 14-page, illustrated bulletin. (6-187)
Drying and Preheating Foundry Ladles. Ironton Fire Brick Co. This 8-page, illustrated reprint presents an interesting article on the drying and preheating of foundry ladles. (6-185)
Silicon-Carbide Refractories. American Crucible Co. (6-145)

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Fabrication and Repair by Welding. Metal & Thermit Corp. Complete data on fabrication and repair by Thermit welding of crankshafts, axles, cylinders, etc., are presented in a 32-page, illustrated bulletin. (7-375)

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FORMING

Zinc Alloy Dies. National Lead Co. Kirksite "A," a zinc-base alloy for dies and molds for forming, blanking and trimming sheet materials, molding plastics, etc., is described in a 72-page, illustrated handbook, revised edition. (8-657)
Die-Less Duplicating. O'Neil-Irwin Mfg. Co. An original process for die-less duplicating of parts or pieces to die accuracy using DI-ACRO precision machines is described, and the machines profusely illustrated in a 40-page bulletin, No. 45-8. Specifications are included. (8-659)
Extrusion Presses. Schloemann Engineering Corp. This 4-page bulletin profusely describes and illustrates a variety of presses for the extrusion of tubular products, rods, bars, etc. (8-661)
Tangent Benders. Struthers Wells Corp. Three models of hydraulic tangent benders —double wing, single wing and stretch wing—are described and illustrated in a 16-page bulletin, No. 58-T. Specifications are included. (8-662)
Hydraulic Shop Equipment. Watson-Stillman Co. A variety of hydraulic rail benders, wheel benders, crankpin and forcing presses, forged steel valves and fittings, etc., are profusely illustrated and described in a 4-page bulletin. (8-666)
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Forging Furnaces. George J. Hagan Co. (8-230)

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Grinding Wheels. Abrasive Co., Div. Simonds Saw & Steel Co. This 24-page booklet is a supplement to the original grinding wheel data book, and contains a complete table on wheel selections. (8-651)

Carbide Tipped Tools. Allegheny Ludlum Steel Corp. Complete data on Carmet carbide tipped tools, including grades available, coolants, brazing, etc., are presented in a 20-page bulletin. (8-652)

Coolant Separators. Barnes Drill Co. This 10-page bulletin, No. 151-C, profusely illustrates and describes the Barnesdril magnetic-automatic coolant chip separators for honing and grinding machines. Specifications are included (8-654)

Tool-Holder Bits. Carpenter Steel Co. Specifications, prices and brief descriptions of a variety of double-drawn, high-speed tool-holder bits for cutting, finishing, etc. are presented in a 6-page, pocket-size folder. (8-667)

Broaching Machines. Colonial Broach Co. A standard line of improved single-ram broaching machines, specifically designed for surface broaching, is presented in a 4-page, illustrated bulletin, No. VAS-45. Specifications are included. (8-655)

Disc Grinder. Kindt-Collins Co. Bulletin No. B-1, four pages, describes and illustrates several models of a Master, hydraulically-operated, 30-in. disc grinder for all metals, woods and plastics. Specifications are included. (8-656)

Diamond Wheels. Norton Co. New Vitrified Bonded diamond chip breaker wheels for sharpening single-point carbide tools are described and illustrated in a 6-page folder. Specifications are included. (8-658)

Grinding Equipment. Patterson Foundry & Machine Co. Fine and uniform grinding

through the use of jacketed tube mills, continuous feed and discharge ball and tube mills, rod mills, etc. is described and illustrated in a 4-page bulletin. (8-660)

Mill Drills. Steel Tools, Inc. This 2-page bulletin describes and illustrates the Micro-King mill drill for milling and drilling sheet metals and plastics. Specifications are included. (8-663)

Machine Centers. Tungsten Carbide Tool Co. A complete list of machine centers, tipped with Carboloy Grade 44A carbide, is presented in bulletin No. 137. (8-664)

Machine Tools. Walz & Krenzer, Inc. A 4-page bulletin describes and illustrates the facilities of this company, specialists in the design, manufacture and maintenance of industrial and power plant equipment. (8-665)

Tool Shanks and Cutter Bodies. American Brake Shoe Co., Brake Shoe & Castings Div. (8-361)
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Mixers, Agitators, Etc. H. K. Porter Co., Inc., of Pittsburgh, Pa. (8-542)

RIVETING AND FASTENING

Locking System. Bardwell & McAlister, Inc. This 24-page, illustrated bulletin includes nine pages of specifications for the Rosan locking system, which locks threaded inserts and studs in all materials. (8-653)
Screw Thread Inserts. Aircraft Screw Products Co., Inc. (8-507)
Lock Nuts. Columbia Nut & Bolt Co., Inc. (8-593)

Cleaning • Finishing

CLEANING

Metal Cleaning. American Chemical Paint Co. Technical Service Data Sheet No. 3-1-1-2, illustrated, discusses Deoxidine, a phosphoric acid that cleans metal surfaces, removes rust, and preserves paint. (9-536)
Metal Cleaning. Kelite Products, Inc. A scientific process for the cleaning of metal surfaces before low temperature brazing with silver alloys is discussed in a 4-page, illustrated bulletin. (9-531)
Metal Cleaners, Etc. Klem Chemical Works. Fully described processes for cleaning, de-rusting, phosphotizing, soldering and maintenance are presented in an 8-page bulletin. (9-539)
Metal Cleaning. Optimus Detergents Co. Bulletin No. 4D1, four pages, discusses a new line of industrial metal cleaning materials, available in alkaline, acidic, solvent and emulsion types. (9-533)
De-Burring and Finishing. Sturgis Products Co. Roto-Finish, a mechanical process that grinds, de-burrs, polishes, hones and colors steel, brass, aluminum, stainless and nickel steels, is described in a 6-page, illustrated folder. Specifications are included. (9-535)
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Preparing Metal Surfaces. Neilson Chemical Co. of Canada. Several Prep products for protecting paint finishes, such as Metal-prep, a metal cleaner and rust remover, Pre-prite, a rust-preventive phosphate coating for iron and steel surfaces, etc., are described and illustrated in a 4-page bulletin. (9-532)
Acid-Proof Cements. Quigley Co., Inc., Bulletin No. AP-122, eight pages, describes and illustrates 3 acid-proof cements—gray, quick-setting and black—for effectively bonding and repairing acid-resisting masonry structures. (9-534)
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PICKLING

Corrosion Resistant Equipment. Haveg Corp. A complete line of corrosion resistant equipment, such as pipes, valves, tanks, pumps, etc., is presented in a 36-page bulletin, No. F-4. Specifications, physical and chemical properties, and numerous diagrams are included. (9-530)
Corrosion Resistant Ceramics. Atlas Mineral Products Co. (9-72)
Ferric Sulphate and Cartridge Cases. Monsanto Chemical Co., Merrimac Div. (9-176)

POLISHING

Felt Wheels and Bobs. Divine Brothers Co. Dico felt wheels and bobs for use on both soft, ductile metals, such as aluminum, tin or zinc, and extremely hard metals, such as steel forgings or castings, are described and illustrated in a 6-page, pocket-size bulletin. (9-537)

Sanding Wheel. Exactone Tool & Die Co. Sand-O-Flex, a multi-purpose, brush-type sanding and finishing wheel that sands, deburrs, finishes and polishes small metal, plastic, rubber and wooden parts, is described and illustrated in a 4-page bulletin. (9-538)

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Testing • Quality Control

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Magnetic Comparator. General Electric Co. This 2-page bulletin, No. GEA-4169, describes and illustrates a portable magnetic comparator for the quick inspecting of ferrous parts for quality control. Specifications are included. (10-647)

Electronic Controls. Wheelco Instruments Co. A variety of electronic control equipment, such as indicating pyrometers, potentiometers, thermocouples, input controllers, etc., are presented in a 12-page, illustrated bulletin, No. Z6300. Prices are included. (10-651)

Heating Furnace Control. Askania Regulator Co. (10-622)

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Clamp Screw. Wilson Mechanical Instrument Co. (10-607)

INSPECTION DEVICES

Strain Gages. Baldwin Locomotive Works, Baldwin Southwark Div. Bulletin No. 173, four pages, is a reprint of an interesting article on practical strain-gage applications. Numerous diagrams are included. (10-643)

Snap Gages. Federal Products Corp. The Model 1330P-100 series of dial indicator snap gages for accurate gaging of outside diameters of work-pieces are described and illustrated in a 4-page bulletin. (10-645)

Powder Blower. Magnaflux Corp. This single sheet describes and illustrates the XB-2A powder blower for the application of Magnaflux powders to large areas, to vertical or overhead surfaces, and in the inspection of large weldments. (10-652)

Dial Comparators. B. C. Ames Co. (10-549)

Identification of Steel. Dravo Corp. (10-271)

Electronic Metal Identifier. Allen B. DuMont Laboratories, Inc. (10-529)

Shim and Feeler Gage Stock. Industrial Products Suppliers. (10-495)

Surface-Roughness Measurement. Physicists Research Co. (10-524)

Illuminating Magnifiers. E. W. Pike & Co. (10-345)

Electronic Supplies. Walker-Jimieson, Inc. (10-641)

MECHANICAL TESTING

Abrasion-Resistance Testing. Taber Instrument Corp. The Taber Abraser test, which prepares and tests for abrasion resistance practically all materials subject to surface wear, is described in a 16-page, illustrated bulletin. (10-650)

Strain Gages. Baldwin-Southwark Div. (10-341)

Testing Machines. Riehle Testing Machine Div., Am. Machine & Metals, Inc. (10-593)

METALLOGRAPHIC EQUIPMENT

Metallurgical Testing Apparatus. Buehler, Ltd. (10-80)

Metallurgical Polishing Equipment. Precision Scientific Co. (10-319)

RADIOGRAPHY

X-Ray Equipment, Etc. North American Philips Co., Inc. This 8-page bulletin profusely illustrates and describes a variety of electronic products, such as Search-ray inspection units, Geiger-counter X-ray spectrometers, cathode-ray tubes, Norelco X-ray diffraction units, etc. (10-648)

X-Ray Equipment. Picker X-Ray Corp. Five to 50 kvp. industrial X-ray equipment for spot weld control, micro-radiography, inspection of plastics, plywood, etc. are described and illustrated in a 12-page bulletin, No. 1345. (10-649)

Films for Industrial Radiography. Ansco. (10-278)

X-Ray and Radium Protection. Bar-Ray Products. (10-626)

The X-Ray in Industry. General Electric X-Ray Corp. (10-10)

SPECTROGRAPHY

Universal Spectrophotometers. Wilkens-Anderson Co. (10-180)

LABORATORY AIDS

Gas Analysis. Burrell Technical Supply Co. This 96-page catalog, No. 80, presents a complete line of gas analysis equipment, plus a section of technical information for gas analysts. Numerous illustrations and prices are included. (10-644)

Testing Equipment. Gamma Instrument Co., Inc. A complete line of industrial testing and laboratory equipment, and the prices for each, is presented in a 4-page, illustrated bulletin. (10-646)

Please Use the Coupon on Page 1751

Optical Glass. Bausch & Lomb Optical Co. (10-291)

Laboratory Equipment. Central Scientific Co. (10-507)

Carbon and Sulphur Determinator. Harry W. Dietert Co. (10-530)

High-Speed Electrolytic Analysis. E. H. Sargent & Co. (10-219)

Equipment and Machinery, General

Chemical Feed Systems. Milton Roy Pumps. Bulletin No. 451, four pages, describes and illustrates chemical feed systems for feeding various chemicals to boilers for the prevention of scale, to control alkalinity, etc. (11-341)

Dust and Fume Collector. Claude B. Schneible Co. Bulletin No. 145, four pages, describes and illustrates the portable Type "EC" Multi-Wash dust and fume collector for collecting dust from isolated operations or machines that are not linked into a central dust collecting system. Specifications are included. (11-342)

Colloidal Graphite. Acheson Colloids Corp. (11-147)

Dust Control. American Air Filter Co., Inc. (11-229)

Pulverized Coal. Amsler-Morton Co., Inc. (11-162)

Dry Chemical Fire Extinguishers. Ansul Chemical Co. (11-310)

Production Research. Battelle Memorial Inst. (11-296)

Mounted Wheels for Portable Tools. Chicago Wheel & Mfg. Co. (11-70)

Filters. Cuno Engineering Corp. (11-121)

Magnetic Separators. Dings Magnetic Separator Co. (11-232)

Linograph Transfer Paper. Eastman Kodak Co. (11-293)

Refrigeration and Air Conditioning Equipment. General Electric Co. (11-243)

Fluid Cooler. Gray-Mills Co. (11-211)

Oil Filters. Hilliard Corp. (11-306)

Hydraulic Equipment. Hydraulic Machinery, Inc. (11-201)

Compressors and Blowers. Ingersoll-Rand Co. (11-315)

Heat Transfer. International Nickel Co., Inc. (11-169)

Impregnating Castings. Jackson & Church Co. (11-222)

Vibration Control. Korfund Co., Inc. (11-319)

Steam Condenser. Niagara Blower Co. (11-328)

Dust Preventives. Parsons Engineering Corp. (11-233)

Dust and Fume Control. Peters-Dalton, Inc. (11-242)

Silicates. Philadelphia Quartz Co. (11-145)

Centrifugal Blowers. Roots-Connersville Blower Corp. (11-102)

Lubrication for Steam Turbines. Sinclair Refining Co., Inc. (11-197)

Portable Sump Tank. Spencer Turbine Co. (11-219)

High Vacuum Pumps. F. J. Stokes Machine Co. (11-152)

Mill Floor Cleaner. G. H. Tennant Co. (11-368)

Wire Handles. E. H. Titchener & Co. (11-281)

Filters. U. S. Hoffman Machinery Corp., Filtration Div. (11-339)

Transmissions. Western Manufacturing Co. (11-340)

engineering NEWS

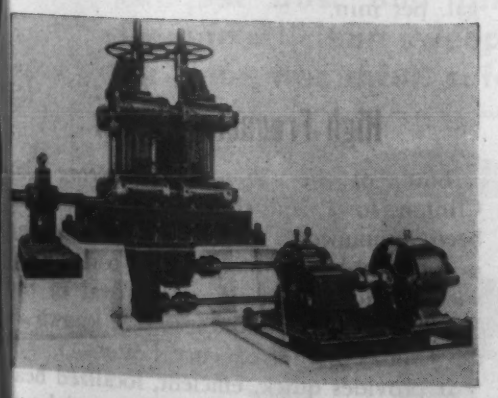
of the metal-working industries

These rather surprising developments are highly interesting as showing the broad extent to which these materials are being used in the war effort. It would be a satisfaction to know in just what applications the various types are used but some of this is probably a military secret. It would be gratifying if the data on these

Vertical Precision Rolling Mill

A new type vertical precision mill built by *Mackintosh-Hemphill Co.*, Pittsburgh, rolls accurate rounds, from 3/8 in. to 1½ in. in diam., a large percentage of which can be rolled within cold drawn tolerances. It can be set up to edge shapes and flats. The mill has simple and rigid design. All adjustments are easy to make, and all movable parts are securely locked, with adjustments and locking devices readily accessible.

A pair of vertical rolls is located immediately after the finishing stand of the tandem mill train. The roll stand can be moved



horizontally to line up the pass line with any pass in the horizontal rolls of the finishing stand. They can be adjusted vertically, so that any pass of the vertical rolls can be lined up with any pass of the horizontal rolls in the tandem mill. Roll housings of the precision mill are also adjustable with respect to each roll to control the size of the product.

The rolls are 12 in. in diam. by 15 in. long, and are supported by anti-friction roll neck bearings in a cast steel carrier, adjustable vertically in a cast steel housing of rugged construction, locked in place to eliminate any movement due to rolling pressures. This housing is connected to a similar housing, holding the opposite roll, by four heavy columns.

Distance between the roll housings is adjustable by nuts on both sides of one housing. When an adjustment is made and the nuts tighten, the two roll assemblies are practically one unit. Vernier scales are on all adjustments for accurate control of the size of the roll pass.

Blind Rivet Gun

A new, compact, lightweight rivet gun, the G-35, is a recent development of the *Cherry Rivet Co.*, 231 Winston St., Los Angeles 13. Designed for installing Cherry blind rivets in hard-to-get-at blind spots, it is operated with one hand—installs the rivet from one side of the job, with a pulling force, and eliminates the necessity of a man on the other side of the rivet.

It is suitable in aircraft, sheet metal, radio, marine, railroad, automotive, furniture, plywood, rubber, plastics, and almost any soft or brittle material.

The gun is small, compact, flexible, measures 11½ in. in length, weighs 1½ lb., is well-balanced for easy one-hand operation. The pulling head is notched so that it snaps onto or off the gun quickly and easily, allowing greater gun flexibility, quicker head interchange. This gun is especially adaptable for cramped installations.

Pulling heads are interchangeable for any standard Cherry blind rivet, aluminum, copper or steel. The gun is inexpensive, and may be purchased singly or in a special kit, Cherry Kit No. 35, along with a selection of rivets.

● A new solid cast steel cutting tool is introduced by *Crobalt, Inc.*, 1344 N. Main St., Ann Arbor, Mich. It is produced by melting special cobalt steel alloy in an indirect arc rocking electric furnace, superheating to well above 3000 F. and casting in molds of the approximate tool size. This gives the metal a preferred grain and carbide particle size at the time of casting, eliminating forging and heat treatment. The tool retains is cutting ability much longer than heretofore possible, with cutting speeds increased 20%. They are supplied hardened and ground, can be resharpened and used as long as they can be held in the holder.

IT'S BOKER TODAY

From Coast . . . To Coast

THE TALK OF THE MACHINE SHOPS WHEREVER BOKER'S TOOL STEELS ARE USED

"They Satisfy"

TWIN MO 2 — The Latest Type Tungsten Molybdenum High Speed Steel

KINITE — High Carbon, chrome, air hardening bar steel and castings

NOVO — 18-4-1 Type High Speed Steel

EST. BOKER 1837

H. BOKER & CO., Inc.

101 DUANE ST. ● NEW YORK

Checking Set for Hardness Testers

A master diamond checking set is now available for checking the accuracy of hardness testing equipment. A product of *Clark Instrument, Inc.*, 10200 Ford Road, Dearborn, Mich., it can be used on all Clark hardness testers and other instruments used for Rockwell testing.

It consists of a gold-plated diamond penetrator and two test blocks. The penetrator is carefully made to exceedingly close tolerances to give the highly accurate measurements required for checking readings. Since designed only for checking purposes, it retains its original accuracy for a long time. When checking, the master diamond penetrator replaces the regular penetrator in the machine.

The same is true of the two master test blocks. Held to extremely close limits, they are used only in connection with the master diamond. The resulting combination furnishes a very accurate check of the machine either as a periodical measure or whenever readings may be in doubt.

● A new strainer used on machine tools for straining cutting oils and coolants is announced by *Geo. Butler Co.*, 1061 W. Washington Blvd., Chicago. Called the Metex, no strainer housing is needed, being installed in the tank, with the liquid piped direct from strainer to pump. It consists of a combination of wire and cotton, interknitted into a mesh by special machines. It has a large strainage area and exceptional capacity to hold foreign matter. Units slip in and out easily. Sizes range from 2 to 60 gal. per min.

High Frequency Heater

Entry of the *Climax Engineering Co.*, Clinton, Iowa, into the electronics field has been announced. Preliminary engineering is completed and pilot models constructed, with production awaiting approval of the WPB. The new product will be known as the Climax high frequency heater.

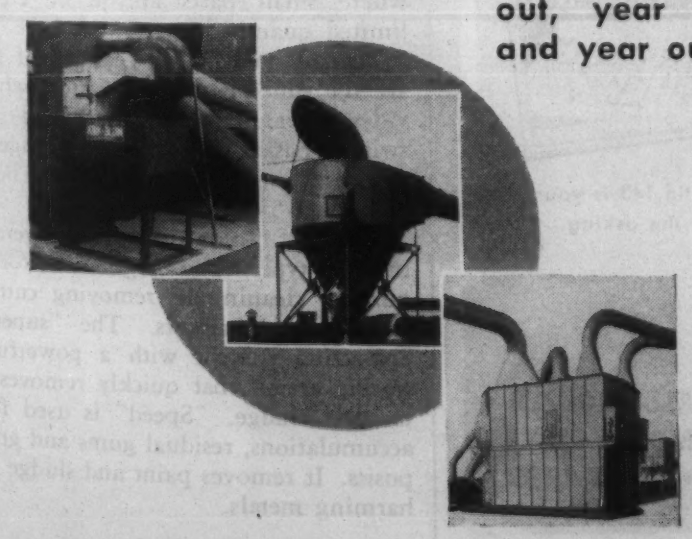
It provides quick, efficient, localized heat for surface hardening, annealing and brazing as an induction heater, and is adaptable as a dielectric heater for non-metallic materials.

Climax expects to produce 12 models of standard electronic heaters, and is establishing an electronics division for their manufacture, engineering, distribution and sale

MAKE A *Clean Sweep* OF *Destructive* DUST!

Dust and fumes are insidious, deadly enemies of production efficiency. They can wreak havoc on workers' health . . . lower productive output . . . impair valuable machinery and equipment.

For 38 years, Kirk & Blum has been waging a successful war against these twin foes of modern industrial efficiency. Control systems installed by Kirk & Blum conquer dust and fumes—and remove them in a "clean sweep" that leaves plant air clear, healthful, safe—day in and day out, year in and year out.



The basic reason for this superior performance lies in the long-experienced "know-how" and scientific approach of K & B Air Engineers. Requirements of the individual plant are first thoroughly, expertly analyzed. Then—and only then— a complete dust or fume control system is planned, designed and installed to meet those *particular plant requirements*.

Let the professional experience of K&B Air Engineers be *your* guide to lasting satisfaction in this highly technical field—just as it has been for other industrial plants the nation over. For details, write THE KIRK & BLUM MFG. CO., 2852 Spring Grove Ave., Cincinnati 25, Ohio.

Send for Booklets

Dust Control Systems in Metal Industries
Fan Systems for Various Industries
Blower Systems for Woodworking Plants
Cooling Systems for the Glass Industry
Industrial Ovens
Data on Kirk & Blum Production Facilities

KIRK AND BLUM

TODAY you can name any number of instances where life itself depends upon the reliability of individual engine or machinery parts. In aircraft for instance. And that's one reason why so many leading engine and machinery builders are specifying Shenango-Penn centrifugal castings . . . because these castings definitely offer superior strength and durability.

The reason is simple. Tubular parts cast by Shenango-Penn's centrifugal process have greater density, more uniform grain structure, higher tensile strength, better elongation, no blowholes, less porosity. Thus they are better able to withstand shock and all kinds of punishment, and they wear longer.

So if you require tubular or ring parts that must *not* part, Shenango-Penn castings are the best kind of insurance. Bulletin 143 gives complete data including cost-saving production advantages, alloy specifications, physical and chemical properties, etc. Write to Shenango-Penn Mold Company, 1557 W. Third Street, Dover, Ohio.

The circular parts shown above were cast centrifugally by Shenango-Penn in tubular shapes and then cut off to precise thickness. All machining and finishing operations including drilling were also performed in the Shenango-Penn shops where the most modern machine tools are available to turn out completely finished parts if desired.

Data Bulletin 143 is yours free for the asking.

ARMY E NAVY SHENANGO -PENN P

ALL BRONZES • MONEL METAL • ALLOY IRONS

All-Angle Magnifiers

Inspection work demanding careful scrutiny of small objects is performed more accurately and easily with Ullman C-Master magnifiers. Newest additions to this well-known line are three recently developed all-angle, illuminated models. Two of these are stand models, and the third is a portable hand type.

The lighting equipment of the Stand Model 410 and Portable Model 610 consists of four incandescent tubes that can be lighted two at a time or all four at once. Two fluorescent tubes are used in Stand Model 210.

Shadowfree, compact, and easy to handle, all three models are ideal for continuous inspection where magnification plus light is required. A large, clear 4½-in. double convex lens, ground and polished, magnifies all objects twice up. Squinting and eyestrain are eliminated, since these all-angle, swivel-action magnifiers provide undistorted view of work inspected.

Strongly built of cast aluminum and steel with bronze bearings, these magnifiers have real value in the tool room and wherever it is desirable to magnify objects in the best possible light. They are made by *Ullman Products Co.*, 857 Fourth Ave., Brooklyn 32.

● A new material, Chanite Flux, made by *Chanite Laboratories*, 914 S. Main St., Fort Worth 3, Texas, is used for repairing electrical heating elements. When the heating wire is burned in two, one joins both ends together, either by stretching one wire or splicing with another. One dips a matchstick in water and then into this flux and applies to the severed wire ends, holding in place with the match. The electric plug is put in the socket and the element welds itself together. The Chanite has 500 times the resistivity of carbon. It has greater resistance than the original heating elements.

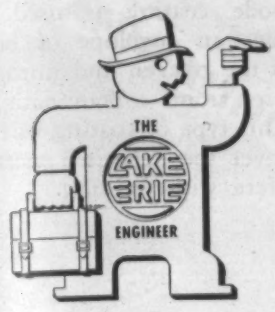
Cleaning System and Solvent

A new small parts cleaning system, known as the Model P-72, and a new line of cold cleaning solvents called "Agitene," is announced by the *Gray-Mills Co.* 1948 Ridge Ave., Evanston, Ill. The P-72 is used for removing cutting oils and lubricants used in metal working operations, and is ideal for many simple cleaning operations where small parts are to be cleaned in limited quantities.

Several outstanding features of the P-72 are the time-saving Air-gitator, which provides air agitation of the (cold) solvent, swisher basket and platform, hinged cover, air hose and "T" connection. The size is 15½ by 15½ by 11½ in.

Agitene (cold) cleaning solvents come in three types. The "regular" is for general purpose cleaning in removing cutting oils and other lubricants. The "super" is a fast-acting solvent with a powerful penetrating action that quickly removes grease, tar and sludge. "Speed" is used for hard accumulations, residual gums and grease deposits. It removes paint and sludge without harming metals.

Another proving ground for plastics



One of the largest producers of phenolic resins uses this 200 ton Lake Erie Hydraulic Press to prove under actual manufacturing conditions the qualities of their molding compounds.

From it has come many of the advancements in product development and methods of molding the versatile materials which they supply to other manufacturers.

Realizing the great future of plastics Lake Erie engineers have made a thorough study of all types of fabricating methods. Already we have designed standard compression molding presses that can be adapted to your needs—or we can build presses to meet any special production methods you may require. Write for complete information.

LAKE ERIE ENGINEERING CORP.
512 Woodward Avenue
Buffalo 17, N. Y.

LAKE ERIE
ENGINEERING CORP.
BUFFALO, N.Y. U.S.A.

Attractive Stainless Steel Flatware . . .

finished with the aid of

LEA Methods and LEA Compositions

Here is an example of fine stainless steel merchandise, a product of International Silver Co., Meriden, Conn. As with numerous other International Silver products—most of them distinctly military in character—the finish is an important factor. And, as with numerous other products, LEA Methods and LEA Compositions are used to help produce the desired results economically.

The services of LEA Technical Men and Laboratory Staff are available to any firm in industry having trouble with the finishing of its products—trouble with burring, with polishing, with buffing. Write us in full. If possible, send us samples for study and recommendations.

ARMY E NAVY

THE LEA MANUFACTURING CO.

WATERBURY 86, CONNECTICUT

Burring, Buffing and Polishing . . . Manufacturers and Specialists in the Development of Production Methods and Compositions

6-LM-4

● The use of a.c. welding, particularly for vertical and over-head work, has been hampered by the lack of an all-position a.c. electrode capable of producing highest quality weld metal. Long a research project, an a.c. electrode, known as the ACP, has emerged from *Westinghouse* laboratories; it meets the requirements of the U. S. Navy Dept. Bureau of Ships and the standards for welding set by various associations. The new electrode includes an arc pacifier that prevents excessive spatter loss during the negative half cycles and an arc stabilizer to aid in reestablishing the arc after each current zero. For best performance on vertical and overhead arc welding, a high-organic electrode coating is used. This coating provides an envelope of burning gas that keeps the oxygen and nitrogen in the atmosphere from contaminating the weld metal. This type of coating leaves but a scanty slag over the deposited metal that does not interfere with welding.

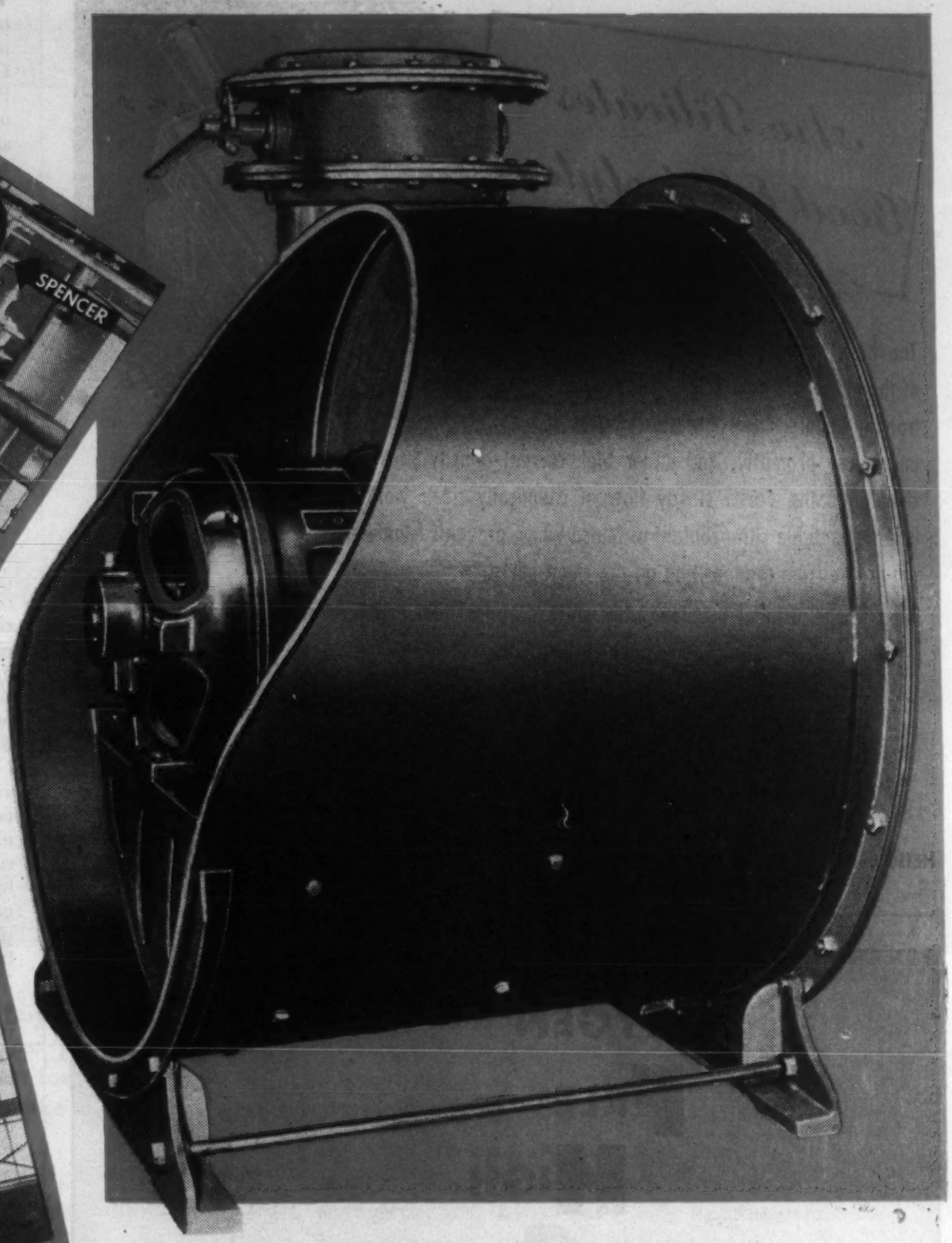
Printer-Developer

Printing and developing facilities for those who require black and white prints in medium quantities are afforded by the new BW Model 41 machine of *Charles Bruning Co., Inc.,* 4754 Montrose Ave., Chicago 41. The printer has a speed range up to 6 ft. per min., depending on the transparency of the original. It prints either roll stock or cut sheets, with a printing width of 46 in.

The light source is a 2,000-watt glass mercury vapor lamp within a 6-in. diam. cylinder, with uniform light distribution. Uniform cylinder temperature within a few degrees is maintained. Speed is controlled by a single knob.

Suction through the bands simplifies feeding of tracings and sensitized paper. The tangential method of feeding prevents damage. A front pedal at floor level instantly releases band tension so that mis-feeding of roll stock is easily corrected.

In the developing unit, speed in excess of maximum printer speed assures an uninterrupted flow of prints. A new type ironing roll results in flat, dry prints.



and . . .

STRESS RELIEVING
HEATING FOR FORGING
SPHEROIDIZING
HEAT TREATING GEARS
MELTING
BAKING PORCELAIN
BAKING CORES AND MOLDS
HEAT TREATING PARTS
HEAT TREATING TOOL STEELS

Select any industrial process involving oil or gas-fired equipment, and you will find that Spencer Turbos are prominent in that field.

Pick any one of the leading manufacturers of heat-treating equipment and you will find that Spencer Turbos have been their preference for many years.

The reasons: A simplicity of design—as simple as a fan, as sturdy as a bridge—with wide clearances and only two bearings to grease—plus automatic maintenance of pressure regardless of load.

These and many other facts are contained in the Spencer Bulletins and the Spencer Turbo Data Book—Yours for the asking.

THE SPENCER TURBINE COMPANY • HARTFORD 6, CONNECTICUT

257-C

TURBO-COMPRESSORS

The high conductivity of the Metso solution for electrolytic cleaning gets grease removal under way promptly. And under high current density you also can count on stable cleaning baths. For a steady flow of chemically clean work you need the help of the balanced soluble silica content of Metso which prevents removed oil and grease from redepositing on the clean parts.

Have you a cleaning problem with which a Metso field engineer may coöperate in solving? Write us today.

PHILADELPHIA QUARTZ CO., Dept. C. 125 S. Third St., Phila. 6

METSO Active Alkali REG. U.S. PAT. OFF.

metso Cleaners

METSO GRANULAR Sodium Metasilicate
U.S. Pat. 1898707

METSO 99 Sodium Sesquisilicate
U.S. Pat. 1948730, 2145749

OXYGEN FREE HIGH CONDUCTIVITY COPPER

OFHC REG. U.S. PAT. OFF.

- Hitherto the distribution of O.F.H.C. Copper has been restricted to certain special end uses such as electronics.
- O.F.H.C. Copper and a few special dilute alloys thereof are now available for most uses.

THE AMERICAN METAL COMPANY, LTD.
61 Broadway, New York, N. Y.

● A new plastic, developed for the Navy, has relative high flame-resistance, low toxicity, easy moldability and shock resistance. Developed by *General Electric Co.*, 1285 Boston Ave., Bridgeport 2, Conn., one type uses asbestos as an inorganic filler, while another type uses glass, the latter being used as panel board on ships and made by bonding layers of glass cloth together with melamine resin in high-pressure presses. Where organic filler was used in experiments, the material gave off toxic gases fatal to human beings. The plastic well withstands vibrations from heavy gun fire.

Two-Stage Surge Washer

A two-stage surge washer for smaller parts in baskets, using an emulsion (or alkali) cleaner and water rinse, is introduced by *Phillips Mfg. Co.*, Touhy Ave., Chicago 45. The unit comprises two compartments with an insulated wall between, one container the cleaner, the other the rinse. The mechanism is reciprocating, moving the rack on which the basket rests up and down through the cleaner and rinse, accommodating two baskets simultaneously, one through the cleaner, the other through the rinse.

This reciprocating cycle moves the baskets vertically, producing the maximum of agitation. Either surge platform will accommodate basket loads of 50 lb., operated singly or together. The machine is 40 in. long by 21 in. wide. Each tank holds 16½ gal. of solvent or water, and each surge platform takes baskets 14 in. sq. by 6 in. high.

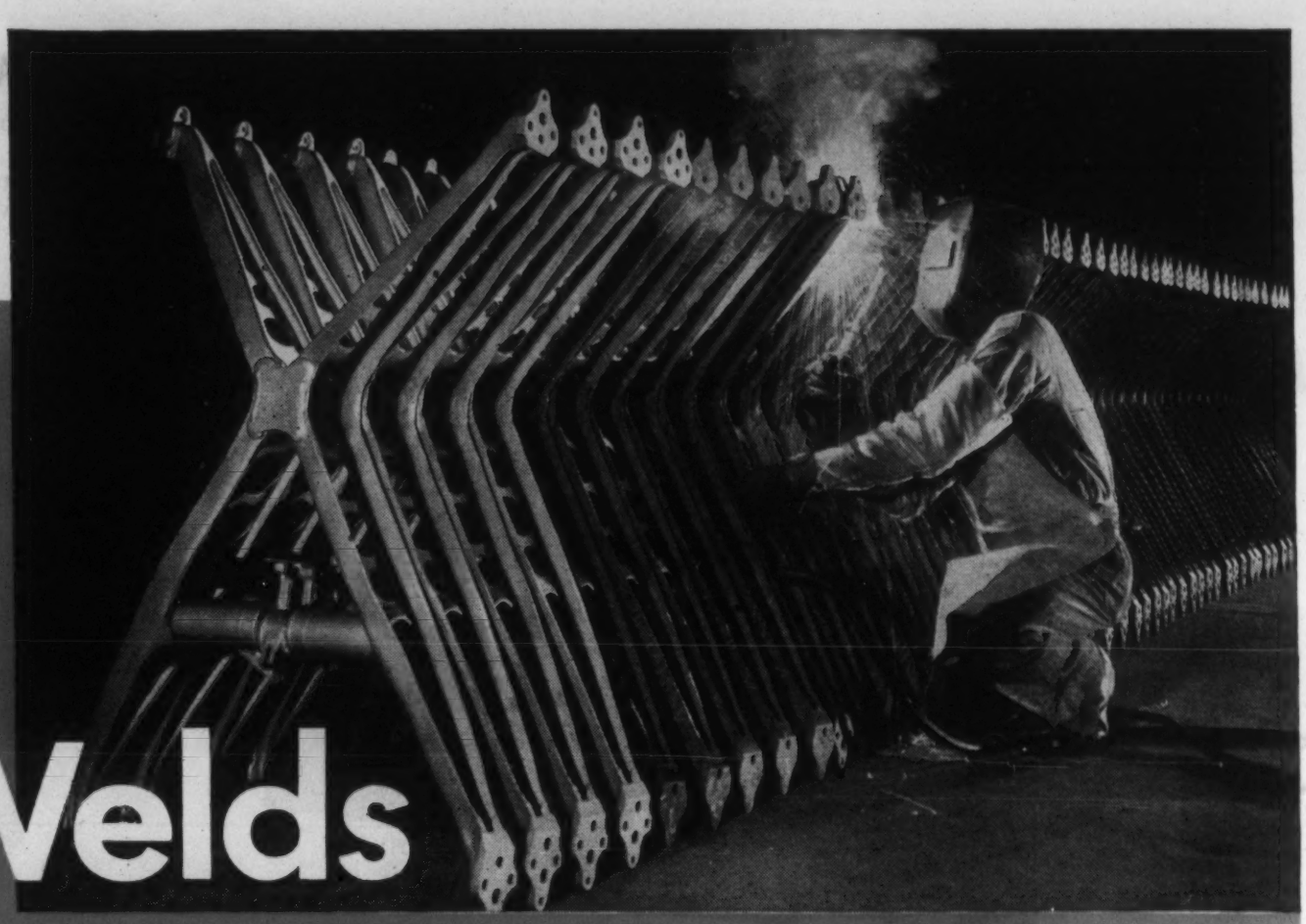
The reciprocating action is powered by a ⅓ h.p. motor, and the machine is offered in four models: Unheated, with heated solvent tank, with heated rinse tank, and with both tanks heated.

Heated tanks are provided with automatic thermostatic controls that keep the temperature of the solution to within plus or minus 5 F. The water rinse tank provides for overflow, and can be fitted with a flow control valve. It can thus be unheated, utilizing the supply of hot water where present, or be heated where hot water is not readily available.

It may be used with any cleaning compound that does not adversely affect galvanized steel. The surge washer is also provided with a hinged cover that locks into position as a draining board to drain the solvent back into the tank before baskets are placed into the rinsing compartment.

● Airplane propeller blades can be machined several times faster than formerly by the hydraulic follower attachment of the *Turchan Follower Machine Co.*, Detroit. Formerly, this was a hand job like large and complex die sinking, involving milling, rough grinding and hand finishing. The new machine duplicates the blade contours with a planer—and in $^1/_{20}$th the time. On one job, tolerance requirements are within 0.008 in. per in., measured transversely against a master template from a cut made in SAE 4340 steel at a speed of 40 ft. per min.

SMITHWAY Electrodes in action—Welding press-formed alloy steel truss members at 13 points assured adequate strength, boosted production and saved materials and finished weight on C-47 landing gear trusses, as compared with former forged steel construction.



13 Welds - BROKE A BOTTLENECK

SAVING 56% in material ... 34% in weight!

WHEN the U. S. Army's vital C-47 cargo plane was ready for mass production, there just wasn't enough drop forge capacity available in the nation to make the landing gear trusses pictured above.

So the part was redesigned for welding with SMITHway electrodes, and the bottleneck disappeared.

In this vital war emergency, welding as a production tool had replaced forgings with stampings, had avoided extensive machining time, had saved 106 pounds per unit of critical alloys, and assured unlimited production speed.

SMITHway Certified Welding Electrodes are vital factors in this and many other modern welding achievements. Now available for your use, too! They are helping win recognition for *welding* as a great production tool . . . as the best method for fabricating most products of steel. Write for catalog . . . and make the most of WELDING!

Buy an Extra War Bond This Month!

Mild Steel . . . High Tensile . . . and Stainless Steel

WELDING ELECTRODES

made by welders . . . for welders

SMITHway Welding Monitor trains better welders, faster.

SMITHway A. C. Welding Machine saves power; eliminates arc blow.

SMITHway Certified WELDING ELECTRODES

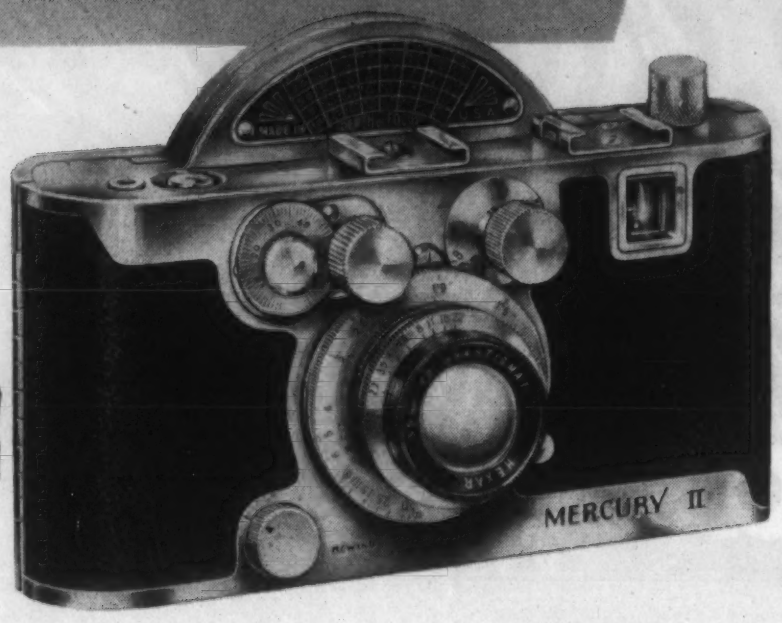
A. O. SMITH Corporation

NEW YORK 17 • PITTSBURGH 19 • CHICAGO 4 • TULSA 3

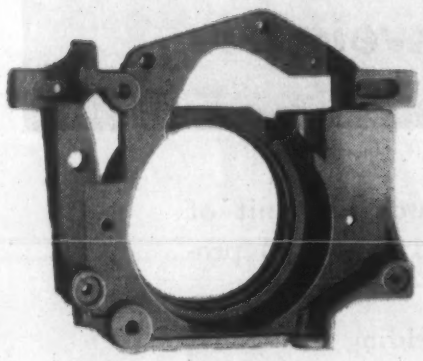
HOUSTON 2 • DALLAS 1 • LOS ANGELES 14 • SEATTLE 1

International Division: MILWAUKEE 1 • In Canada: JOHN INGLIS CO., LIMITED

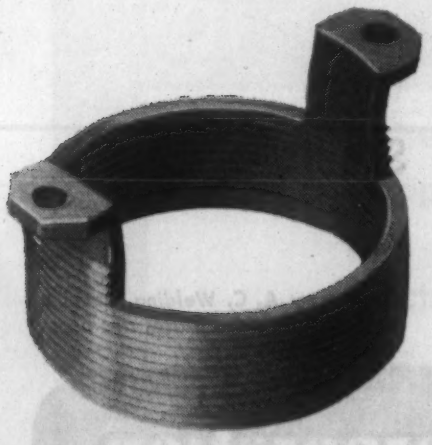
DIE-CASTING ACCURACY DEMONSTRATED IN PRECISION CAMERAS



Universal Camera Corp. Selects Advance Die-Castings for Their Complex, Miniature Mercury Instrument.



The zinc mechanism frame die-cast by Advance, on which are mounted no less than 238 parts is a marvel of intricacy with accuracy. The focusing mount includes an Advance die-cast inner sleeve with cast external threads, demonstrating the ability to die-cast finely threaded parts with extreme accuracy.



Designers of high speed miniature cameras of today and tomorrow are finding modern precision die-castings essential to the amazing accuracy, light weight, compactness and economy which make this type of instrument immensely popular.

In the Mercury II, made by Universal Camera Corp., of New York, aluminum and zinc castings are employed extensively. The fact that numerous complicated die-castings can render dependable precision performance on a camera only 5½" x 2¾" x 1⅜" is a tribute to the engineering skill and craftsmanship of this rapidly growing industry.

The enthusiasm of Universal Camera Corp's engineers over the use of Advance die-castings is prophetic of the widening scope of die-castings in post war fabrication.

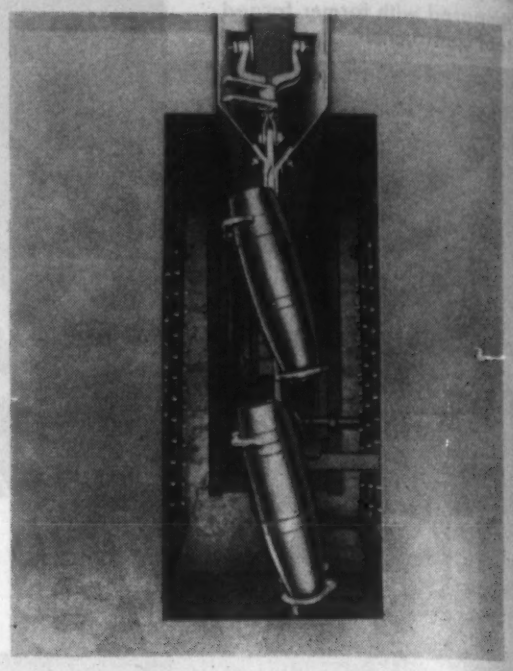
ADVANCE PRESSURE CASTINGS, INC.

ENGINEERS, DESIGNERS AND MANUFACTURERS OF DIE-CASTINGS OF "QUALITY WITH ECONOMY"

48 NORTH 15th STREET BROOKLYN 22, N. Y.

Machine to Apply Phosphate Coatings

Monorail and conveyor type spray cleaning machines to apply phosphate coating on metal parts prior to plating are now being made by *N. Ransohoff, Inc.*, Cincinnati 16. The coating provides better adhesion between the metal surface and the paint.



A typical application is the monorail type, 3-stage spray washer for 105-mm. shells, which are run on racks so constructed that they are sprayed both inside and out and carried at a slanting angle to permit drainage. Machines fit into monorail systems already installed in some ammunition plants, but are designed with self-contained monorail where desired.

Improved Compensated Radiation Pyrometer

Five major improvements are announced in Radiamatics, compensated radiation pyrometers, used in steel mills, metallurgical works, ceramic plants, etc., and made by the *Brown Instrument Co.*, Philadelphia. The instrument consists of a heat resisting lens, compensator and thermopile.

Energy radiated from the hot objects falls on the lens and is focused on the thermopile, which generates an e.m.f. proportional to the object's temperature. The measurements are independent of ambient temperatures.

The five improvements are: Use of an adhesive sealing compound between the lens and mounting ring; use of brass for lens retaining and mounting rings; controlled torque is applied when assembling the lens retaining and mounting rings; two spanner wrench holes in the lens mounting ring face have been replaced with a milled slot, which avoids cutting through the ring face, and use of a more positive sealing, with an improved adhesive, of the sighting glass located in the rear of the thermopile assembly.

Other improvements include use of aluminum instead of cast iron for the Radiamatic housing.

Contrast this *Alcoa extruded shape* with the structural member you'd have to build up to do a comparable job.

Possibilities of the extrusion process surprise the uninitiated. Extrusions save on fabricating labor. They often simplify a design, saving more weight and giving it greater use-value.

Aluminum is employed most efficiently, being placed exactly where needed for utility and strength. No excess metal for joining purposes. No rivets to add extra weight.

Dies for the extrusion of aluminum are very reasonable in cost. Our engineers will gladly discuss the shapes you need and help you figure what you'll gain by going to Alcoa Aluminum extruded shapes. ALUMINUM COMPANY OF AMERICA, 2162 Gulf Building, Pittsburgh 19, Pennsylvania.

ALCOA FIRST IN **ALUMINUM**

ALCOA ALUMINUM

INSTANTANEOUS ACCURACY

with

ENGELHARD

Portable Indicating Pyrometers

Engelhard Portable Indicating Pyrometers combine the necessary attributes of accuracy and instancy which distinguish the completely efficient precision instrument.

High resistance per millivolt assures a degree of accuracy unaffected by connecting lead length or by thermocouples of different resistances.

Direct deflection construction permits instantaneous readings easily in either millivolts or degrees.

The conveniently portable instrument is a complete unit in a sturdy carrying case with removable cover.

The 6" scale length indicator may be calibrated with 100 to 150 divisions. Scale range may be selected to suit specific applications. Every indicator is equipped with the Engelhard frictionless moving coils.

All indicators may be furnished with two scale calibrations —for rare metal and base metal thermocouples. By a simple change of lead connections readings are made on either scale.

WRITE FOR BULLETIN 28315-R

CHARLES ENGELHARD, INCORPORATED

90 CHESTNUT ST., NEWARK, NEW JERSEY

General Purpose Shielded Arc Electrode

A new shielded arc electrode for general purpose welding of mild steel, which offers outstanding advantages, is announced by the *Lincoln Electric Co.*, Cleveland. Designated as "Fleetweld 47," it provides extremely low spatter loss, easy slag removal (most welds are practically self-cleaning), excellent restriking characteristics, and other improved features.

It conforms to AWS electrode specifications Class E-6012 and E-6013, and may be used with either alternating or direct current. "Fleetweld 47" is especially well suited for high-speed horizontal or flat fillet welds over 4 in. long, in which the coating can be dragged on both plates. It is also excellent for both vertical and overhead fillets, especially where large single pass fillets are desired.

The ease of complete slag removal on square edge butt welds makes it exceptionally excellent. Complete penetration of ¼-in. plate can be obtained by welding one pass from each side. It is available in 5/32 in. by 14 in.; 3/16 in. by 14 in.; ¼ in. by 18 in. and 5/16 in. by 18 in. sizes. The electrodes are packed in 50-lb. containers.

● An improved file cleaner that cleans off lead, copper, aluminum and soft steel chips is announced by *Cincinnati Tool Co.*, 4082 Montgomery Rd., Cincinnati 12. It is called the Hargrave file cleaner, with chip plow. A special square plate is fastened to the frame of the cleaner. One strikes one edge on the file, thus impressing the tooth pattern on the edge. The plow is then pushed parallel to the file grooves when it plows out the imbedded chips and dirt. When a file of different tooth-spacing is to be cleaned, a new edge of the plate is used. When non-metallic dirt is to be removed, the regular file card with its tempered steel wire teeth is used.

Electrode for Copper and Alloys

A new and unusual electrode for arc welding, a coated special bronze alloy, used for welding bronze, brass and copper, is announced by the *Eutectic Welding Alloys Co.*, 40 Worth St., New York 13. Known as "Eutectrode 28," it contains an unusual combination of metals and is shielded with a newly devised flux coating that makes it suitable for use either on a.c. or d.c. current. This is the first time, as far as is known, that any rod of this type has been able to perform on both direct current and alternating current.

It will deposit dense and tough metal that is a good color match to most types of bronzes. It will give the welded area substantially the same corrosion resistance as these various base metals possess. It may also be used for welding copper and brass, or joining these metals to steel, cast iron, or nickel alloys, and for overlaying steel or cast iron to provide a good bearing surface.

It is available in 1/8 in. and 3/16 in. diam., and can be identified by a light green tip.

equals a single piece in all essential properties

This brass Distributor Shield, used in army tanks, is fully as strong, fully as able to withstand severe stresses and strains, fully as liquid and gas-tight, as if it were a single piece of metal.

For the low-temperature silver brazing alloy EASY-FLO, consistently makes joints equal to solid metal in all essential properties—and does it fast and economically. That's why today, EASY-FLO brazed construction, is an accepted and widely used production method.

In addition to the hundreds of parts for both war and domestic equipment designed from scratch for EASY-FLO brazed construction, hundreds of others formerly cast, forged, machined from the solid, threaded, riveted and bolted, have been redesigned to get the benefit of savings in metal, man-hours, machine-hours and costs that go with EASY-FLO brazed construction.

GET EASY-FLO FACTS NOW — IN BULLETIN 12-A

EASY-FLO brazing speed, reliability and economy will continue to be as important a factor in future production as it has been in war production. Now is the time for design and production engineers to check up on its possibilities. Bulletin 12-A gives full details. Write for a copy today.

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FOUNDED 1867
QUALITY SERVICE

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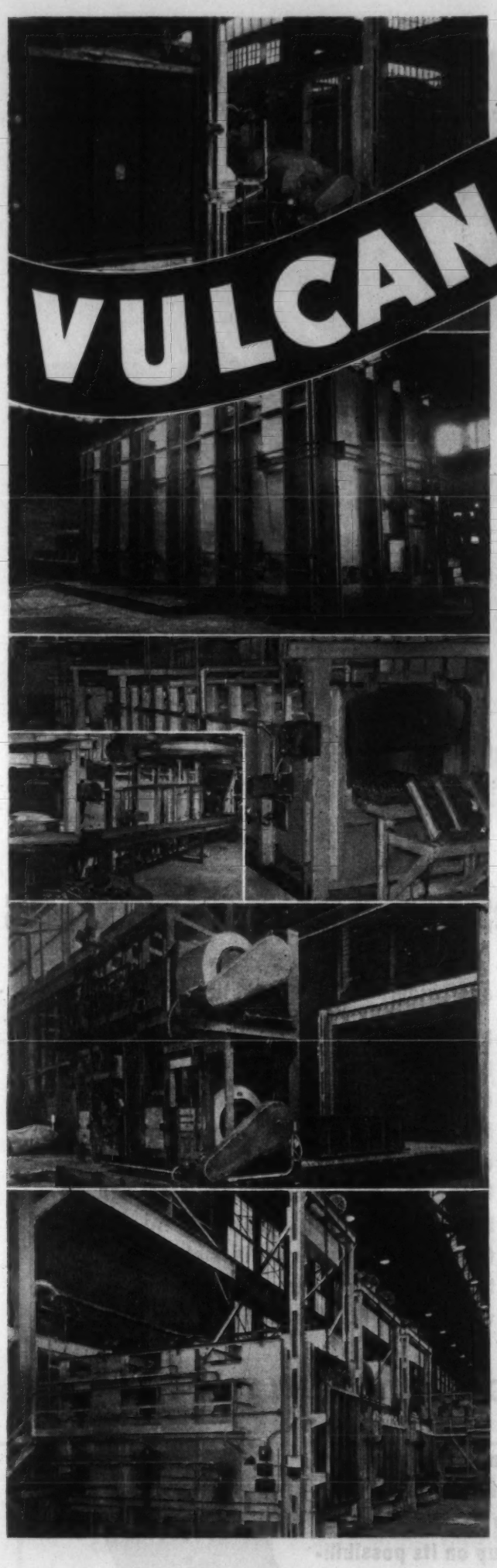


VULCAN Furnaces

FOR ALL HEATING AND HEAT TREATING OPERATIONS

Fast . . . Accurate
Economical

Faster treatment cycles, closer temperature uniformity, greater ease in handling even the heaviest charges, and construction that stands firm under continuous operation, are among the reasons for the efficient and profitable operation of Vulcan Furnaces. Although engineered to produce predetermined results, their cost is comparable to furnaces of standard design, and they can generally be installed promptly.

1. Direct fired furnace (left) for annealing and normalizing miscellaneous castings at temperatures up to 1800°F. Convection furnace (right) for stress relief of castings and weldments at maximum temperature of 1150°F. May be oil or gas fired.

2. High-velocity convection furnace for stress relief and heat treatment of Class A Weldments. Temperature range, 1075°F. to 1750°F. Door is mounted on car to overcome limitations in available height.

3. Continuous hardening, quenching, drawing unit for treating miscellaneous castings and forgings. Both hardening and draw furnaces have roller rail and hydraulic pusher, and are equipped with roller conveyor (inset) for return of trays. Production: 1000 lbs. to 1500 lbs. per hour.

4. One-hundred-ton car hearth furnace for stress relief of marine equipment weldments. Automatic program control of heating, soaking, cooling. Motorized car and door. Temperature range up to 1400°F. Oil fired.

5. Battery of three oil fired car hearth furnaces for treatment of miscellaneous forgings and weldments. Furnace No. 1 (foreground) is direct fired and used for annealing and normalizing at maximum temperature of 1700°F. Furnaces No. 2 and No. 3 are convection heated and used for normalizing at maximum temperature of 1250°F.

An imposing list of installations demonstrates the important part allotted to Vulcan Furnaces in the Nation's war effort. Consult us regarding *your* requirements.

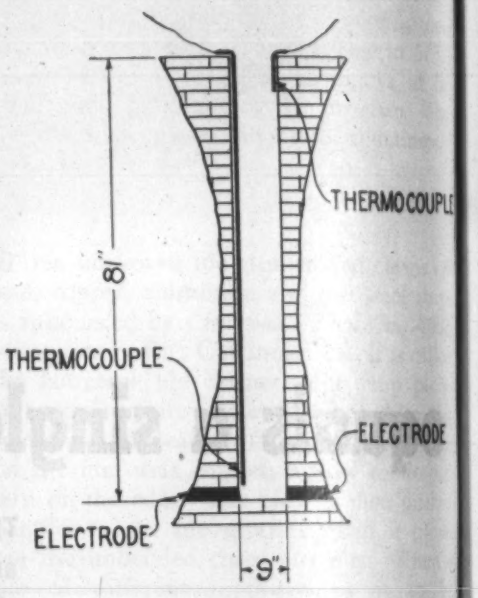
VULCAN CORPORATION
114 NORTH 17TH STREET, PHILADELPHIA 3, PA.

Salt Bath Furnace, Extremely Deep

A new internally heated electric salt bath furnace of exceptional size especially designed and built for heat treating (in vertical position) long broaches and similar work, which are likely to distort when heat treated horizontally, has just been announced by *Upton Electric Furnace Div., Commerce Pattern Foundry & Machine Co.*, 7450 Melville at Green, Detroit 17. The noteworthy feature is its extreme depth in comparison with its surface area, or 81 in. against 9 in. sq. for its surface.

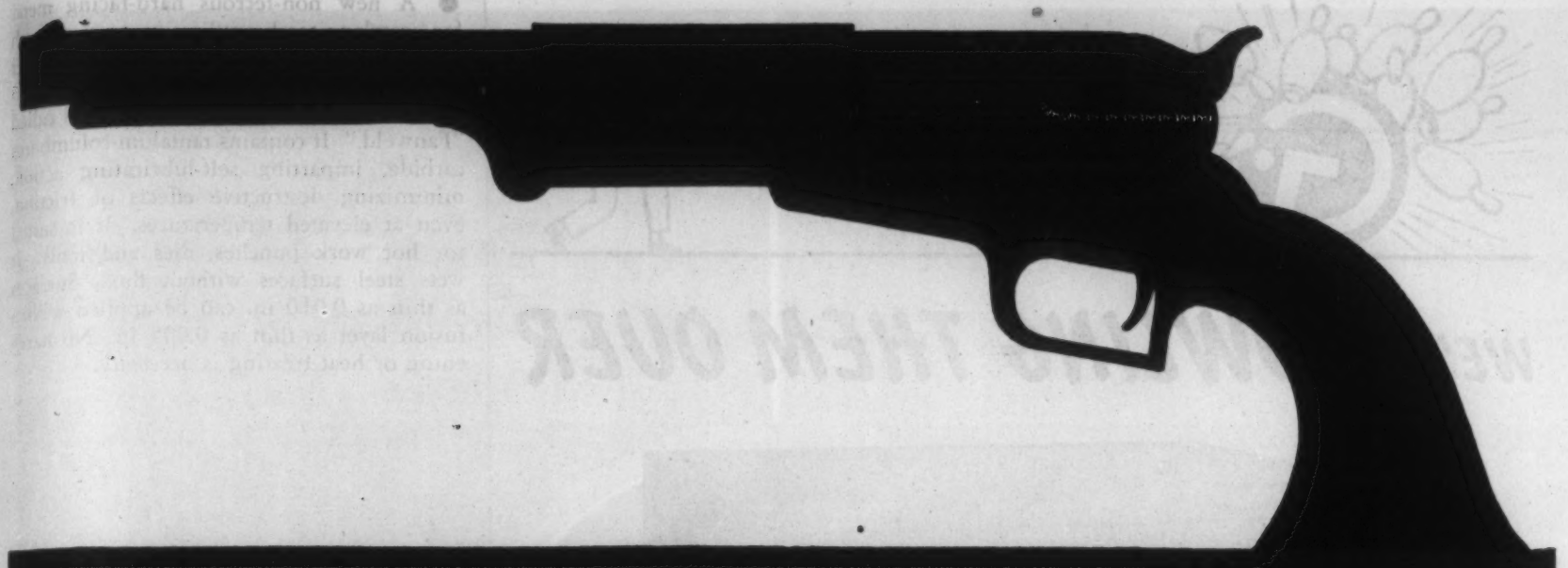
Upton electrodes enter through the sides of the furnace and at the bottom of the pot, in contrast with other types that require approximately 25% of the working area. Thus, with no space required for electrodes in the working area of the pot itself, the pot need be only of sufficiently large surface area to admit the work.

Proof is furnished in actual operation where, while a temperature drop of 4 F.



(just enough to actuate the "on" and "off" controller) can take place at the bottom of the pot, the molten salt at the top of the pot remains at practically constant temperature. Moreover, when long pieces of cold work are introduced into the bath, there is a uniform drop in temperature through the entire bath.

● An organic acid pickling inhibitor in powdered form, Pennsalt PM-40, has been developed by the *Pennsylvania Salt Mfg. Co.*, 1000 Widener Bldg., Philadelphia 7. It is highly stable and completely soluble in pickling baths of muriatic or sulphuric acid. It contains 100% active ingredients, and is highly effective at such low concentrations as 0.02% to 0.10%, by weight of the pickling bath. Concentrations may be varied to meet conditions. This material effects economies in both acid and metal, while minimum quantities of inhibitor are required. Due to high base metal protection, the acid is consumed principally in scale and rust removal, with the result that the useful life of the bath is prolonged. It can be used in acid pickle baths prior to electroplating, galvanizing and enameling, since it is free-rinsing and minimizes hydrogen absorption.



WHEN THIS REVOLVER WAS INVENTED —

40-YEAR-OLD FREEDOM FORGE WAS PRODUCING 800 TONS OF BLOOMS A YEAR —

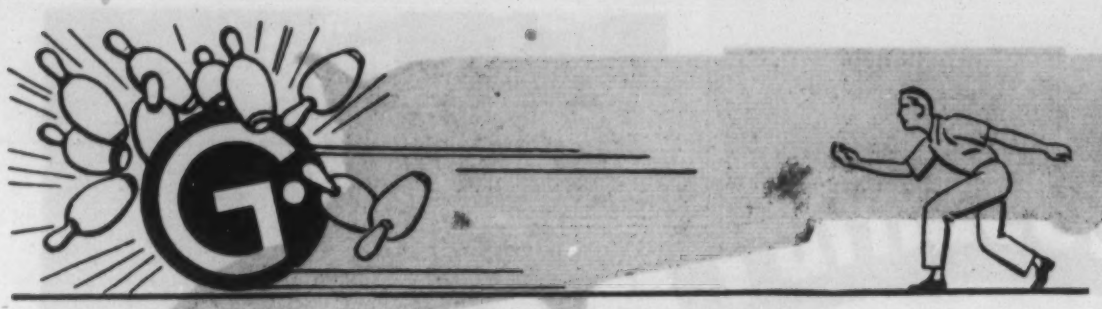
With the name still a household word, it is hard to believe that the Colt revolver is 110 years old. It has been an important weapon in every war, played a big part in opening up the West in the days when every man had to be prepared to battle Indians or desperadoes at a moment's notice, and was the first step in the trend to modern automatic weapons that give today's squad the fire power of yesterday's regiment.

When the Colt revolver was invented, Freedom Forge—now Baldwin's Standard Steel Works Division—had already been turning our ferrous products for 40 years. The plant was rebuilt in 1835, with one chafery and six refinery fires, giving a capacity of 800 tons of blooms annually. Throughout the intervening time it has been an important supplier to American Industry, producing the metals that helped to fight each war, serving the railroads that helped to knit the nation together, supplying industry with castings and forgings to help work producton miracles.

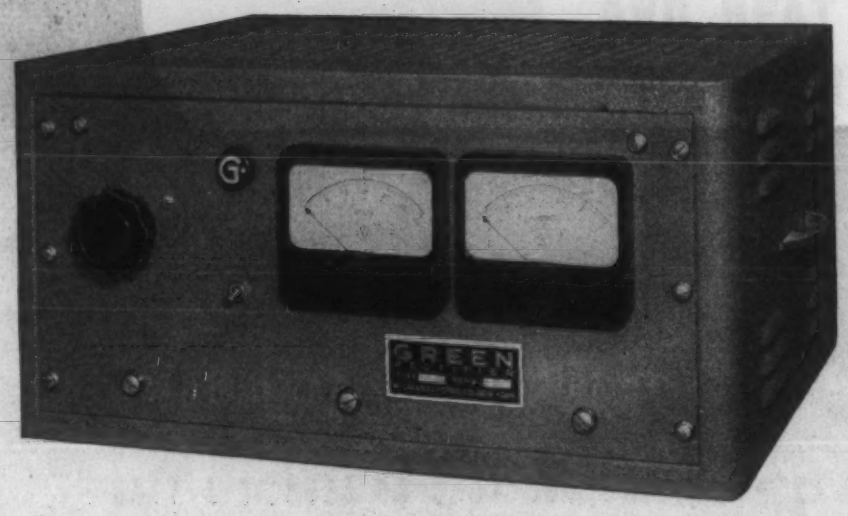
When you need castings and forgings that are out-of-the-ordinary in size, complication or service qualities, you'll find 150 years of experience waiting to serve you. Whatever your needs, the best way to be sure of satisfaction is to "Standardize on Standard." The Baldwin Locomotive Works, Standard Steel Works Division, Burnham, Pa., U.S.A. Offices: Philadelphia New York, Washington, Boston, Cleveland, Detroit, Chicago, St. Louis, San Francisco, Houston, Pittsburgh.

BALDWIN

STEEL FORGINGS & CASTINGS



WE'RE BOWLING THEM OVER



That refers to engineers who have special applications for D.C. power and find that we can design and build *anything* they need.

Metal plate or tubes—high voltage or low—high current or low—filtered or unfiltered—anything that calls for rectifier power is right down our alley.

Talk to Green Electric or to their representatives.

FREDERIC B. STEVENS, INC.
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202 Emmett Street
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A. J. LYNCH & COMPANY
2424 Enterprise Street
Los Angeles 21, California

CROWN RHEOSTAT & SUPPLY COMPANY
1910 Maypole Avenue
Chicago 12, Illinois

"Rectifier Engineering is our Business"

If you're knitting your brow about DC power, present or post-war, put your problem in the lap of a friendly Green engineer.

· SELENIUM · ARGON · MERCURY VAPOR · GRID CONTROL · HIGH VACUUM · XENON

W. GREEN ELECTRIC COMPANY, INC.
SELECTRO PLATERS AND ALL TYPES OF RECTIFIER EQUIPMENT
GREEN EXCHANGE BUILDING 130 CEDAR STREET NEW YORK 6, N.Y.
RECTIFIER G ENGINEERS

● A new non-ferrous hard-facing metal for acetylene torch application to steel, with marked resistance to abrasion, heat, impact and erosion, is announced by *Fansteel Metallurgical Corp.*, N. Chicago, Ill., and called "Fanweld." It contains tantalum-columbium carbide, imparting self-lubricating action, minimizing destructive effects of friction, even at elevated temperatures. It is suited for hot work punches, dies and tools. It wets steel surfaces without flux. Surfaces as thin as 0.010 in. can be applied with a fusion layer as thin as 0.005 in. No hardening or heat treating is necessary.

Unique Plug Gages

A new plug type gage, a bore checking gage of the fixed limit type that is unique in appearance and accomplishments, is announced by the *Standard Gage Co.*, Poughkeepsie, N. Y. The small sizes, from 0.240 in. to 1.510 in. diam., have the "go" and "not go" gaging members attached to the opposite ends of a light weight metal handle. Sizes from 1.510 in. to 6.010 in. are single end gages, individually mounted on palm-fitting plastic handles.

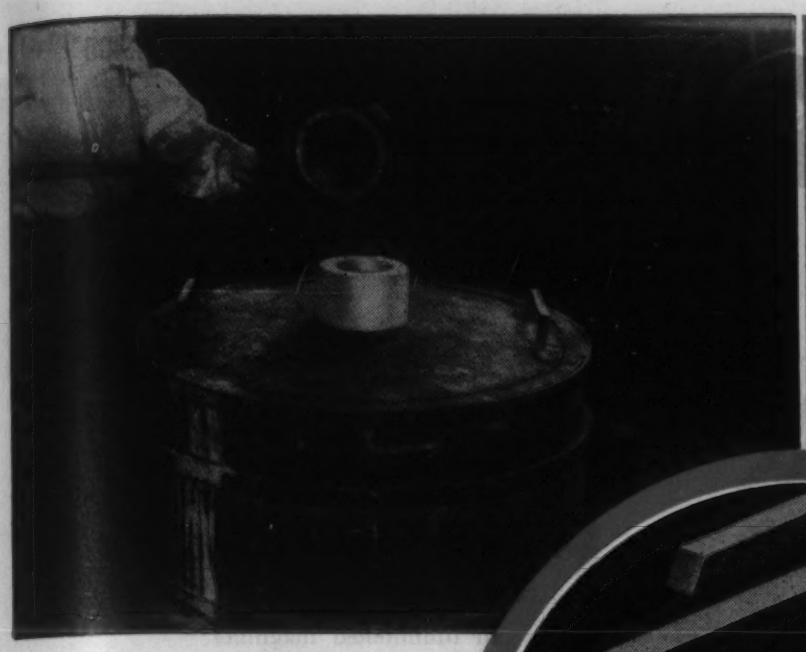
"Go" members of both the double and single end "Dubo" gages are marked with a broad band of vivid green enamel under a durable, transparent plastic ring; "not go" by brilliant red bands. The handles of the double end gages also carry corresponding dots of color.

The Dubo gage head is a relatively thin disk, which is a section of a sphere. The spherical gaging surface makes contact with the bore walls only at the instant and point of bore gaging. Two chamfered sections, diametrically opposed on each member, make it possible, by slightly tilting the handle, to enter the gage into bores easily, without force or fumbling or running the risk of marring even highly polished work pieces.

A gage without chamfer can be inserted in a bore only a comparatively short way. The Dubo, on the contrary, can be used to check deep bores, as the handle need be tilted only slightly when applying the gage and does not touch the bore walls.

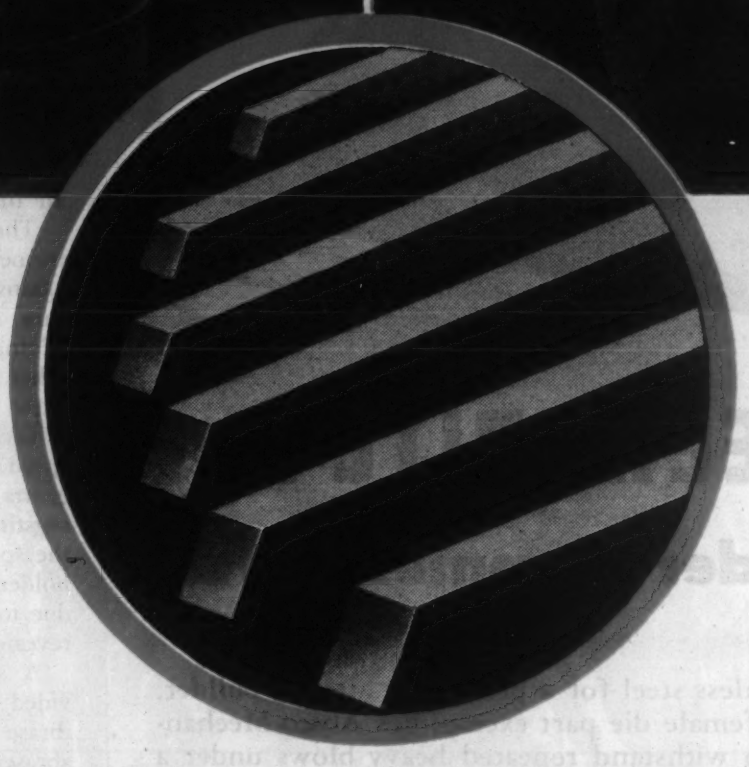
The design of the gaging members also permits accurate gaging almost to the bottom of blind bores. The chamfer edge serves an additional function in tending to wipe away foreign material from the gaging area and thus helps to prepare a clean surface for accurate gaging.

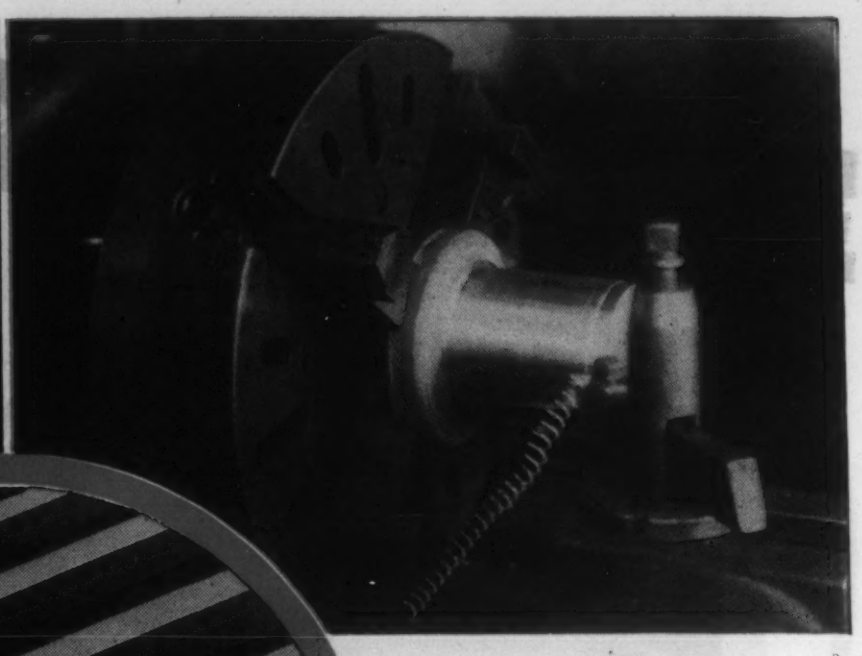
In use, only a small portion of the gaging surface makes contact with the surface of the bore walls. This materially reduces wear on the gage and also focuses the gaging contact to a very small area. As the Dubo gage may be introduced into bores smaller than its diameter, it provides a means for checking out-of-roundness and taper, even when these conditions are on the minimum side of the tolerance or smaller than the go dimension. It is consequently possible to check a back taper in a part which the ordinary fixed limit gage could not enter and to discover faults which conventional plug gages might bridge.



In the making

Illustrating how ALX Cast Alloy Tool Bits are poured on a centrifugal spinner. The metal is weighed first to assure filling the mold without insufficiency or waste.





On the job

A 7/16" ALX Tool Bit rough-turning a Type 309 (25-12) stainless steel forging of 4-1/4" diameter, taking a 1/8" cut at a speed of 140 feet per minute, with a feed of .020".

Announcing ALX CAST ALLOY TOOL BITS — FAST CUTTING NON FERROUS TOOL BITS CONTAINING BORON

OUR most recent development in the field of cutting materials, ALX Cast Alloy Tool Bits, is the result of complete and thorough research investigation in the Allegheny Ludlum Laboratories, and exhaustive machining tests in the field.

Produced by advanced methods of centrifugal casting, ALX Alloy is a highly homogenous metal, with consequent advantage in cutting properties. It possesses high hardness in the as-cast condition, requiring no further heat treatment. In performance, ALX rates between carbide metal-tipped tools and high speed steel. It rounds out and completes the Allegheny Ludlum line of cutting materials—which includes Carmet carbide metals and a wide selection of high and low-tungsten and "moly" high speed steels—giving us the utmost range in supplying the tools best fitted for each individual job.

Ground and finished ALX Cast Alloy Tools, both in solid and tipped bits, are available in a complete range of sizes from our own and distributors' warehouse stocks. They fully merit serious investigation and comparative testing on your cutting jobs. The assistance of our Mill Service Staff is at your entire disposal ● Also available is a new and complete bulletin on ALX Tool Bits, giving full data on selection and performance. *Write for your copy.*

Address Dept. MA-32

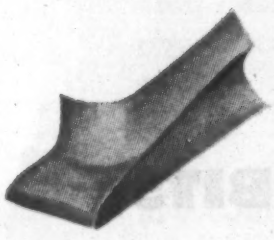
AL

STEEL FOR THE NATION'S WELFARE

Allegheny Ludlum
STEEL CORPORATION
BRACKENRIDGE, PENNSYLVANIA

W & D...9795

ABSCO-MEEHANITE DIES
hold shape under hammer blows



Forming stainless steel for a prominent aircraft builder, this 2194-lb. female die part exemplifies Absco-Meehanite's ability to withstand repeated heavy blows under a large air hammer. It is one of many die castings which have been serving the same manufacturer for several years . . . turning out cowling parts with compound curves, short manifolds and other parts difficult to produce . . . making them from four different thicknesses of steel.

Used in place of less strong, less rigid metals, these cast-to-form dies eliminate excessive machining costs, and require only a light grind finish. Their graphite content gives them valuable self-lubricating characteristics which reduce wear. They retain a high polish in service.

Among the stainless steel products formed on Absco-Meehanite dies are those shown at the left. And the unusual properties which make Absco-Meehanite a good choice for forming dies have proved valuable in drawing and spinning dies also.

ABSCO-MEEHANITE PROPERTIES APPLYING TO THIS CASTING

✔1. Strength (Shear, Compressive, Tensile and Transverse)	5. Heat Resistance
✔2. Impact Resistance	6. Toughness
3. Corrosion Resistance	✔7. Rigidity
✔4. Wear Resistance	8. Machinability
	9. Pressure Tightness
	10. Vibration Absorption

Meehanite castings permit close control of physical properties for your specific application. Write for Meehanite Engineering Handbook

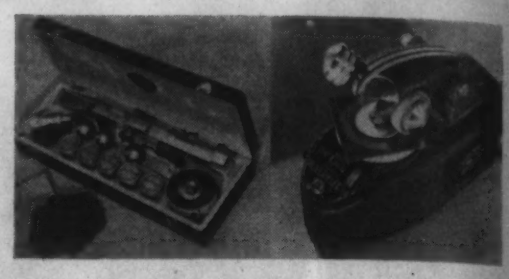
AMERICAN Brake Shoe COMPANY

BRAKE SHOE AND CASTINGS DIVISION
230 Park Ave., New York 17, N. Y.

4059

Set for Testing Abrasion

For determining the wear or abrasion resistance of practically every material subject to surface abrasion, an improved abraser in a complete testing set has been devised by *Taber Instrument Co.*, N. Tonawanda, N. Y. It includes all accessories, together with specimen table, for running tests under



wet or moist conditions. The set includes an illuminated magnifier.

The wearing action of the abraser is performed by dual calibrase wheels bearing against the specimen under constant pressure, revolving in opposite directions, one sliding radially toward the outside and the other sliding toward the inside of the wear path.

Each wheel revolving at a steady constant speed through contact with the specimen exerts a combined abrasive, compressive and twisting action twice in each revolution of the specimen holder. Because the specimen holder travels a complete circle, the wear due to difference of grain or weave is fully revealed.

A standardized load adjustment is provided for varying the pressure of the calibrase wheels against the specimen so the abraser will test both delicate and tough materials with equal precision.

The Taber abraser is self-contained and ready to operate by plugging into an electric line. The results of tests are reported either as the number of "wear cycles" or as "loss in weight" when weighed on a precision laboratory balance.

Laboratory and Pilot Plant Oven

A streamlined, compact and completely self-contained oven has been designed for laboratory and pilot plant use by the *Industrial Oven Engineering Co.*, 11621 Detroit Ave., Cleveland 2. Sizes of oven working space in the new oven range from 3 by 3 by 3 ft. to 6 by 6 by 6 ft., in increments of 1 ft., and special sizes are furnished to specification. Temperatures range up to 900 F., with a guaranteed differential of ± 2 F.

This type of oven is usually furnished with electrical heating equipment, but is designed to use any type of fuel. In every case, the heating equipment is contained within the oven shell. The smaller models are shipped assembled, ready to connect to the heat source.

The oven is designed particularly for precision experimental work in drying, baking, evaporating, polymerizing, aging and heat treating, especially in cases where highly volatile solvents are used. Regardless of the inflammability or explosiveness of the solvents, the oven has insurance company approval.

Number 9 of a Series: **"Looking at the 5 essential things you never see in electrodes!"**

Arc-lit Brooklyn Bridge . . . before the turn of the Century

The Light That Has Never Gone Out!

THE CARBON-ARC STREET LAMP cast its brilliant light long and efficiently over America's great bridges and thoroughfares. Then the arc blazed ahead to become one of industry's most useful tools.

But the light from the old street lamp still shines in the lesson it taught us about selecting exactly the right raw materials for making its "carbons"—forerunners of today's huge carbon and graphite electric-furnace electrodes.

Utmost care in selecting raw materials precedes the manufacture of all "National" carbon and "Acheson" graphite furnace electrodes . . . electrodes that are strongly shock resistant, uniform in size, of high electrical conductivity, and that are consumed slowly.

Raw materials selection, however, is just one of *five* essential things you *never see* in electrodes. The others are manufacturing experience, manufacturing control, continuing research and customer service. You should insist on them all in electrodes. We welcome inquiries.

NATIONAL CARBON — ACHESON GRAPHITE

The words "National" and "Acheson" and the "National" and "Acheson" Seals are registered trade-marks of National Carbon Company, Inc.

KEEP YOUR EYE ON THE INFANTRY . . . THE DOUGHBOY DOES IT!

NATIONAL CARBON COMPANY, INC.
Unit of Union Carbide and Carbon Corporation
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GENERAL OFFICES: 30 East 42nd Street, New York 17, N.Y.
DIVISION SALES OFFICES: Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco
In Canada: Canadian National Carbon Company Limited, Welland, Ontario

"24 Hours does it!"

Cast Special Refractory Shapes with J-M Firecrete

As easy to mix and pour as concrete, Johns-Manville Firecrete permits you to cast special refractory shapes and have them in service as little as 24 hours later!

Firecrete is used extensively for furnace covers and bottoms, door linings, baffle tile, burner rings, pipe linings and other types of monolithic refractory construction . . . it helps you cut costly production stoppages.

Firecrete hardens quickly, has negligible drying and firing shrinkage, is highly resistant to spalling.

Three types: Standard, for temperatures to 2400° F.; H. T., for temperatures to 2800° F.; L.W. (light-weight low-conductivity), for temperatures to 2400° F.

* * *

Write for folder RC-13A. Johns-Manville, 22 E. 40th Street, New York 16, N. Y.

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville FIRECRETE The Standard in Castables

Multiple Stud Welder Unit

A new automatic stud welding development to meet mass production requirements is the Nelson multiple stud welder production unit. Two or more studs may be welded in one operation. The work is rapidly performed, and the studs are held to very close tolerances. Each of the welding guns is mounted on a pneumatic air cylinder. Each cylinder is fixed to a movable arbor that can be adjusted to any spacing necessary.

The work is held in a mandrel, chuck, or special locating device. The welding current is obtained from a conventional 400-amp. generator, and is regulated by a timing control unit which automatically controls the length of arc flow, producing controlled and consistent welds.

The welding unit is operated with a single control switch. The work is inserted, stud is fitted into the chuck of each stud welding gun, and the control switch pressed. The first gun then descends, making a weld. Upon completion of this weld, the next gun descends and welds. The guns then ascend automatically and the work is removed.

Each production unit is manufactured only on order to permit the unit to be made to fit the particular problem. The maker is *Nelson Specialty Welding Equipment Corp.*, 440 Peralta Ave., San Leandro, Calif.

● More than 150 different combinations of *Westinghouse* industrial resistance welding control will soon be possible from only 11 standard basic units. From there it will be possible to factory assemble welding controls that will meet the diversified needs of industry which at present are only available through individually designed and custom-built controls.

Safety Panel for Arc Welders

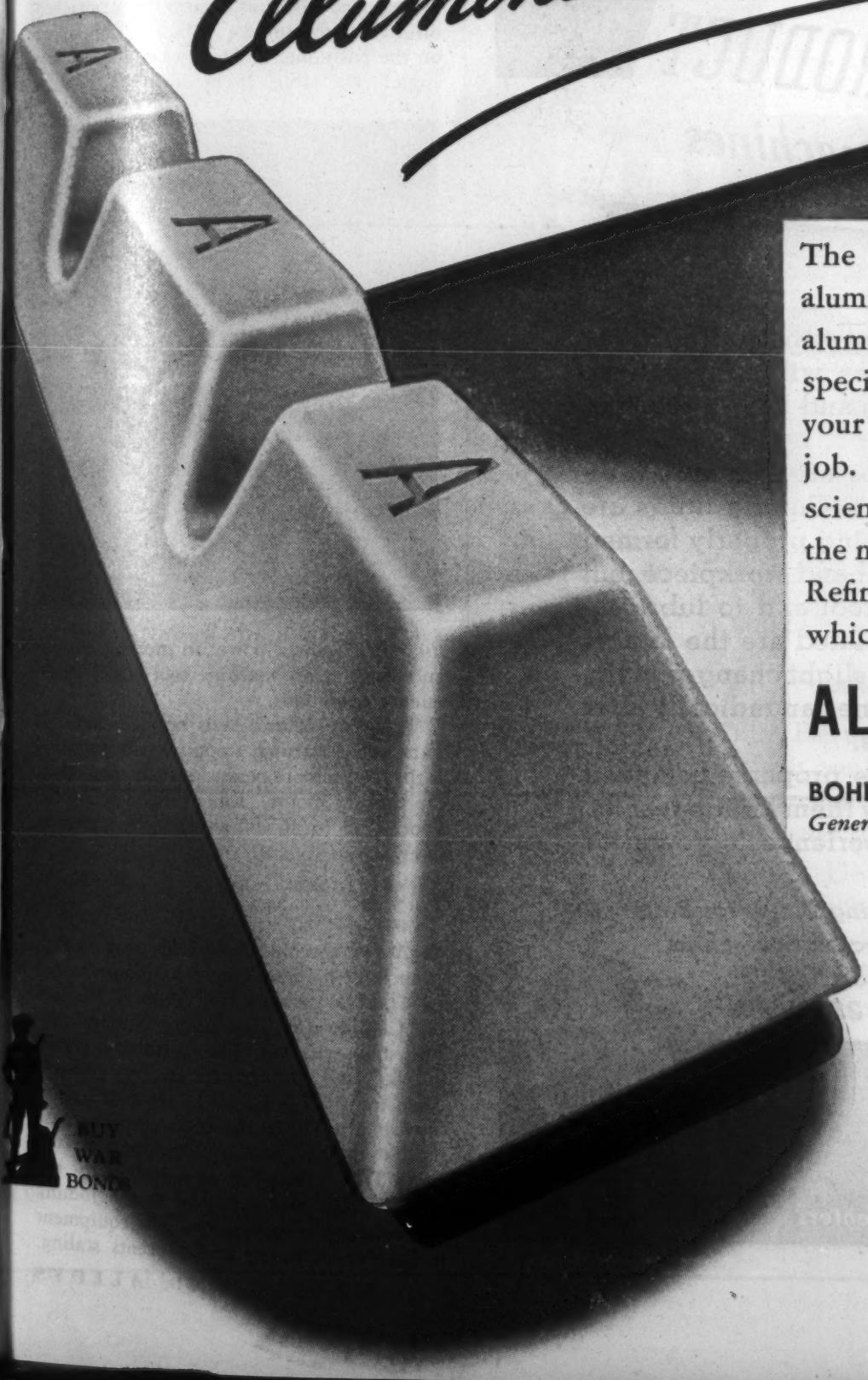
A new safety panel to protect arc welders against shock has been perfected by the Michigan City, Ind. plant of the *Pullman-Standard Car Mfg. Co.* and available to other manufacturers through the *Square D. Co.*, Detroit. High open circuit voltages of most welding equipment create a definite hazard to operators, ranging from 85 to 110 v. Since this voltage is ordinarily present at all times, when not welding, physical contact of the operator from his welding electrode to grounded metal surfaces may have serious consequences.

When the welding contact is broken, this new safety panel automatically reduces this open circuit voltage of the electrode from 110 v. to a mere 24 v. Without the panel, the risk of shock is greater when the operator disengages the work to replace burned out electrodes.

This new control isolates the open circuit voltage of the welding equipment from the electrode holder as soon as the operator breaks the arc or welding spark. A control voltage of 24 v. is then automatically impressed on the electrode cable when the electrode again contacts the work, so that the welding transformer is again connected to the electrode—and welding proceeds.

ALUMINUM REFINERS

℞ Prescription for Good Aluminum Castings



The first step that will go far to remove aluminum casting difficulties is to secure aluminum alloy ingot that is made to your specifications. 25 years of experience is your assurance that we know how to do the job. The very latest refining equipment and scientific laboratory controls supply us with the means to do it. You will find Aluminum Refiners a highly satisfactory source from which to buy your aluminum alloy ingot.

ALUMINUM REFINERS

Division of

BOHN ALUMINUM AND BRASS CORPORATION

General Offices, Lafayette Building • Detroit 26, Michigan

MANUFACTURERS OF ALL TYPES AND SHAPES OF CASTING AND DEOXIDIZING ALLOYS

BUY WAR BONDS

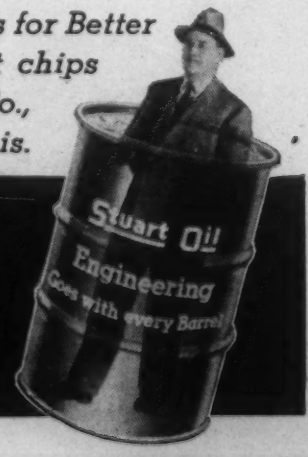
POSTWAR PRODUCT
of a million machines

AFTER V-DAY, reconversion notwithstanding, thousands of metal-working factories will turn out the same products they made during and before the War. The products will be chips.

To the experienced eye, chips are valuable indicators of machining performance. Cutting fluids are a vital consideration in developing properly formed chips—not just to "cool" the tool and workpiece, but to prevent welding of metal to tool and to lubricate heavily loaded areas. So interrelated are the factors of metal-cutting operations that slight changes in the composition of cutting fluids alone can radically alter the shape and direction of chips.

Stuart men know how to make properly balanced cutting fluids—and how to apply them for top results. Through them, 80 years of experience is yours for the asking.

The 60-page Stuart booklet, "Cutting Fluids for Better Machining," contains interesting facts about chips and cutting fluids. Write D. A. Stuart Oil Co., Limited, 2745 So. Troy St., Chicago 23, Illinois.



D. A. Stuart Oil CO.
LIMITED
ESTABLISHED 1865
Stocks in Principal Metal-Working Centers

● Addition of several dozen new sizes of cored and solid bar stock in Oilite materials is announced by *Chrysler Corp., Amplex Div.*, 6501 Harper Ave., Detroit. These self-lubricating bronze and ferrous base materials are excellent for bearings. The new sizes embrace a range of ⅜ in. to more than 12 in. in diam. Although Oilite differs from cast materials in that it is made from metal powders and impregnated with oil, the cored and bar pieces are machined just like a cast bearing.

Multi-Purpose Welding Positioner

A powered welding positioner for rotating work up to 700 lb. at speeds of 0 to 2.4 r.p.m. in either direction by easy hand wheel control is sponsored by *Standard Machinery Co.*, Providence 7. The unit will accommodate table speeds up to 180 in. per min. with a work radius of 1 ft. Linear speeds at all radii are easily set and indicated on a scale on the side of the frame.

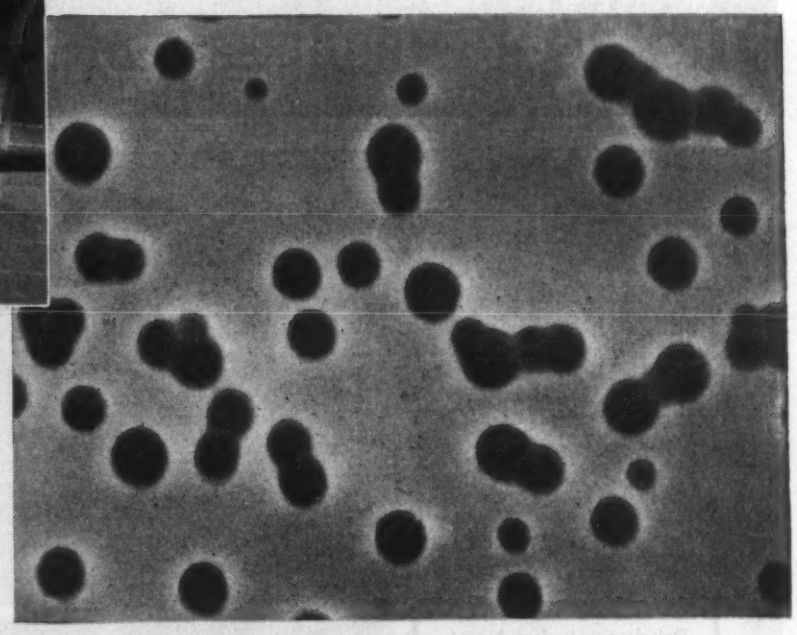
The machine has proven adaptable for moving work past the torch and quench in flame hardening operations. The table can be removed easily, and various jigs attached directly to the spindle. The work mounted on the positioner table may be tilted to any angle: The table, 28 in. in diam., may be

used as a basis of power in moving fixtures and work across machine tool tables in sequence operations.

There are neither belts nor clutches. Instantaneous starting, stopping and reversing is through a foot-operated switch controlling the driving motor. Table height above the floor is 30 to 36 in., adjusted by elevating screw.

● A new specimen holder for Jominy end-quenching hardenability tests is announced by *Claud S. Gordon Co.*, 3000 S. Wallace St., Chicago 16. The holder is a stainless steel shell, with cap. The specimen is placed in the shell and heated in any furnace. Then the shell is placed in the base assembly when a pin in the bottom of the base pushes up the specimen, knocking off the cap. The sample is removed with the Jominy tongs and quenched in the Jominy tank, also made by Gordon. The equipment makes for simplicity and prevents scaling.

Goodyear Tire and Rubber Company Tells How the RCA Electron Microscope Helps Manufacturers



Micrograph made with RCA Electron Microscope showing Synthetic Rubber Latex Particles x 25,000

THE RCA Electron Microscope showed Goodyear scientists that particles of natural rubber latex range in size from as little as 4 millionths of an inch to as much as 160 millionths; and that the size of synthetic latex particles ranges only from 0.8 to 7.2 millionths of an inch. This information indicated to Goodyear research men answers to several questions of great importance to rubber manufacturers, namely:

1. Why has synthetic latex so much greater mechanical stability?
2. Why is it impossible to concentrate synthetic latex by centrifuging, as is done with natural latex?
3. Why has synthetic latex greater viscosity than that of natural latex having the same content of solids?
4. Why does synthetic latex impregnate fabrics more readily than does natural latex?

Here is an excellent example of the practical value of the RCA Electron Microscope—how it helps manufacturers—how it can be used, not only in research but in checking production for particle size, structure, distribution, etc., for better control of product quality.

RCA Electron-Microscope engineers will gladly advise any manufacturer of the probability that an instrument of this type will prove profitable in his work. Please address inquiries to Electron Microscope Section, Radio Corporation of America, Department 116W, Camden, New Jersey.

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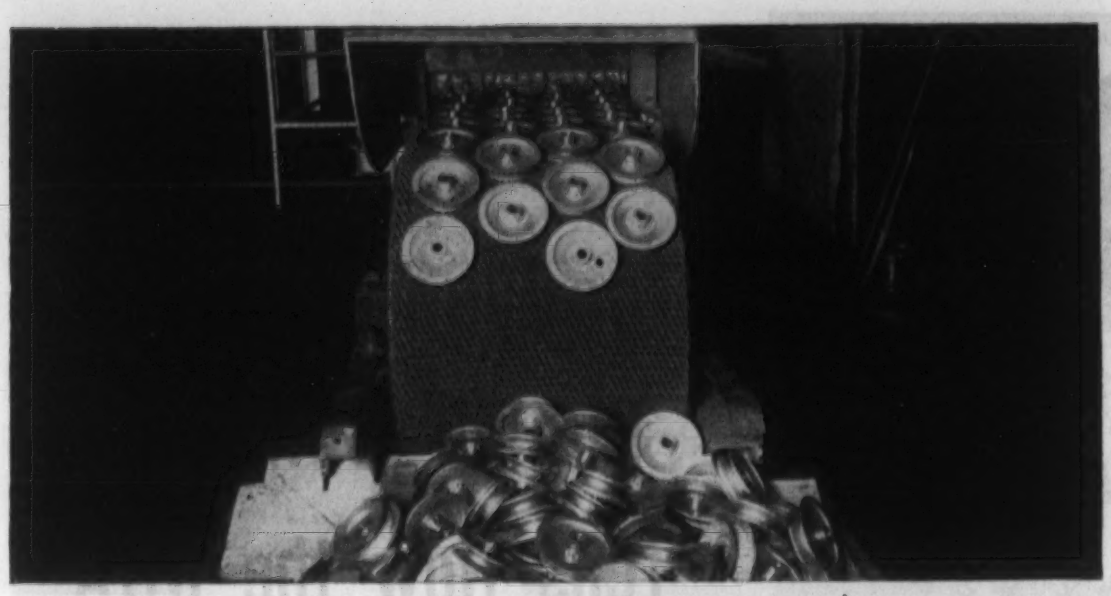
RCA VICTOR DIVISION · CAMDEN, N. J.

In Canada, RCA VICTOR COMPANY LIMITED, Montreal



The Complete Assemblies are Discharged

Securely Joined, Bright, Continuously

. . . from EF Brazing Furnaces

Products requiring several stampings joined or requiring screw machine parts, forgings and stampings to complete the unit, can be neatly and economically joined right in your production line.

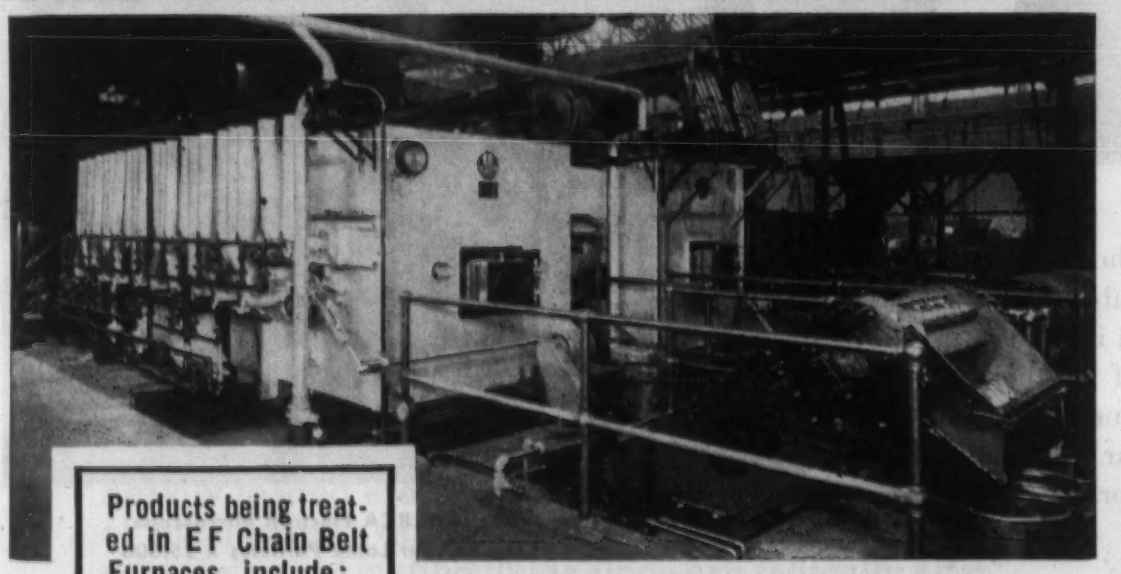
Strong, leak-proof joints are made and the completed unit is discharged from the furnace —clean and bright.
Any number of joints in the same product or any number of pieces can be joined at one time.

Investigate This Process for Joining Your Aluminum, Brass, Copper or Steel Parts.

Send for printed matter showing various types of EF brazing furnaces.

The Electric Furnace Co., Salem, Ohio

Gas Fired, Oil Fired and Electric Furnaces---For Any Process, Product or Production



Products being treated in EF Chain Belt Furnaces, include:

Sprockets
Cap screws
Bolts and nuts
Gears and pinions
Flat springs
Coil springs
Small forgings
Valve springs
Spring plates
Tractor links
Rivets and washers
Wrench & tool parts
Bearing parts —cups and cones
Machine gun cartridge clips
Aircraft engine parts
Automotive parts
Rock bits, and many other products

For Hardening Small Parts

175 to 2000 lbs. per hour

Uniformity — Scale-Free — Continuously

The above gas fired radiant tube chain belt furnace is one of three we installed in one plant. Hundreds are in operation handling products such as listed at left. We build them for gas, oil or electrically heated.

The EF chain belt conveyor type furnace is one of the most satisfactory general purpose furnaces built for the continuous, uniform, economical production heat treatment of small and medium size products. We will be glad to send complete data on these and other types we build.

Send for circulars showing the chain belt and other types of EF production furnaces

The Electric Furnace Co., Salem, Ohio

Gas Fired, Oil Fired and Electric Furnaces---For Any Process, Product or Production

"Electric Eye" Control of Pouring

Automatic control of pouring operations in foundries is now possible with "Photoswitch Photoelectric Control," Type A20c, made by *Photoswitch, Inc.*, 77 Broadway, Cambridge 42, Mass. By previous conventional methods, molds were poured by a manually-operated buggy ladle handled by an operator subject to intense heat from the iron and occasional burns resulting from iron splash.

Now, with the help of "electric eyes," one operator, working from a remote station, controls the pouring of several ladles simultaneously. Several molds are poured in less time than needed to pour one formerly.

When the empty molds are in place, the operator, through push button control of the hydraulic actuating mechanism, tips the ladles of molten iron, and metal flows into the molds. As it reaches the riser, a brilliant light is thrown off—a signal to the "eye" that the mold is full. The ladle drops back and pouring stops.

The "eye," of course, detects minute changes in light intensity, the key principle by which it works. It can also indicate and control the density of gases and turbidity of liquids. It can distinguish between a clear liquid such as water and air above it, or can detect an interface between two liquids differing slightly in translucency.

It operates from 115 v., a.c., 60 cycles, with a single pole, double-throw relay for normally open or closed operation. Relay contacts handle 10 amps., a.c., or 5 amps., d.c.

New Tumbling Barrel Deburring Process

A great variety of precision parts are now being quickly and inexpensively deburred to close tolerances in mass lots, according to the *De Burr Barrel Co.*, manufacturers of De Burrette compound, 4559 Hollywood Blvd., Los Angeles 27.

The process not only deburrs but also imparts a uniformly smooth over-all finish. De Burrettes, used in tumbling barrels, are made of soft neoprene rubber impregnated with aluminum oxide abrasive. As each particle of the abrasive is rubber-mounted, the cutting action is cushioned, and the softest metals are not marred.

The constant, even sliding pressure of the De Burrettes on the metal provides fast cutting action on hardened steel. Tolerances are easily controlled by timing the run. No water is used, and there is no mess or rusting of parts. Tolerance held to 0.001 in. is common.

Steel spacer washers 0.005-in. thick have been deburred, leaving a uniformly smooth finish. Tolerance can be held to 0.0001 in. The process is revolutionary for deburring parts of brass, magnesium, aluminum, steel and iron, castings and stampings as well as precision-machined parts. The manufacturer maintains a pilot plant to test the process on parts sent in by manufacturers, and to establish formulae for De Burretting parts hitherto impossible or too expensive to deburr by other methods.

T & W FORGINGS

Usually Cost Less at the Point of Assembly

There is a difference in the cost of forgings at the point of assembly, and it is due to a noticeable difference in the time cost of machining and finishing. Ask a T & W Forging Engineer how it is that T & W forgings usually cost less at the point of assembly.

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— we'll create a specific alloy to meet your needs

Chances are, your problem has an exact counterpart in one of the hundreds of alloy case histories in our files. The vast accumulation of alloy research data at Niagara Falls Smelting and Refining Corporation is accurate, thorough and always at your disposal. There have been, and we fully anticipate more, occasions when even the completeness of our material was and will be inadequate. However, our laboratories and our research staff have never failed to find the final and correct solution.

It is our established policy to see that you get the Quality Falls Brand Alloy you specify, where and when you want them. You'll find Falls Brand service fully dependable in meeting the most critical production specifications and schedules. Call us today.

Our Telephone Number It's Buffalo Riverside 7812-3-4

NIAGARA FALLS SMELTING & REFINING CORPORATION

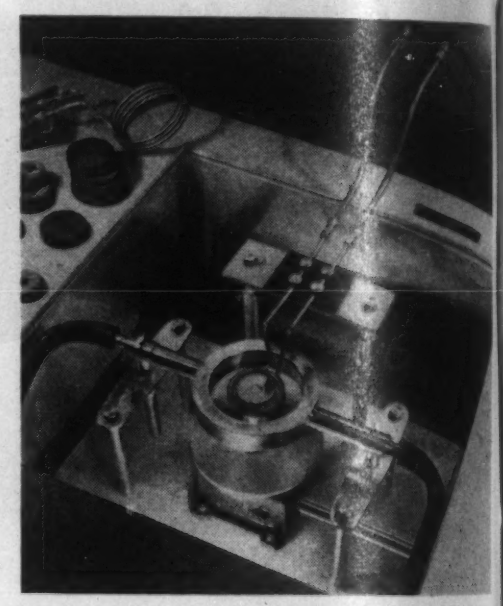
America's Largest Producers of Alloys

BUFFALO 17, NEW YORK

● A new craze-resistant urea-formaldehyde resin adhesive named Urac 183, offering improved bonding for intricate wooden parts where the application of high pressure to secure a uniformly thin, durable glue line has heretofore been extremely difficult, is announced by *Plastics Div., American Cyanamid Co.,* 30 Rockefeller Plaza, New York 20. The new adhesive, having improved features for low-pressure wood assembly work in the aircraft, furniture, automobile, marine, woodworking (including lumber lamination for wooden structures and buildings), sporting goods, and musical instrument industries, greatly reduces the problem of crazing or fine cracking of the glue that causes deterioration of the glue lines. Other advantages are: Greater storage stability, elimination of amylaceous fillers, control of gluelline pH to values acceptable under U. S. and R.C.A.F. specifications, lower cost, and provision of hardener system for summer temperature use.

Induction Heating Gear Hardener

For hardening gears and pinions, a new roto-heating and quenching unit has been developed by *Lepel High Frequency Laboratories, Inc.,* 39 W. 60th St., New York 23. The device causes the part to revolve at a predetermined speed within the load coil



during the automatically-controlled heating and quenching cycles.

The result is a degree of uniformity seldom achieved by any hardening process. The unit, including motor drive, load coils and quench rings, is compact, light in weight, and inexpensive. It can be operated with any standard Lepel induction heating unit.

● A new steam jet for pickling tanks that "heats, while it agitates, while it circulates" has just been developed by the *Youngstown Welding & Engineering Co.,* Youngstown, Ohio. Among the benefits claimed is that it provides a faster and better job of pickling, keeps the strength of the pickling acid uniform in all parts of the tank, reduces steam hammer, has long service life and provides longer tank life, may be located anywhere in the tank, and is easily installed. It is called the "Weldco."

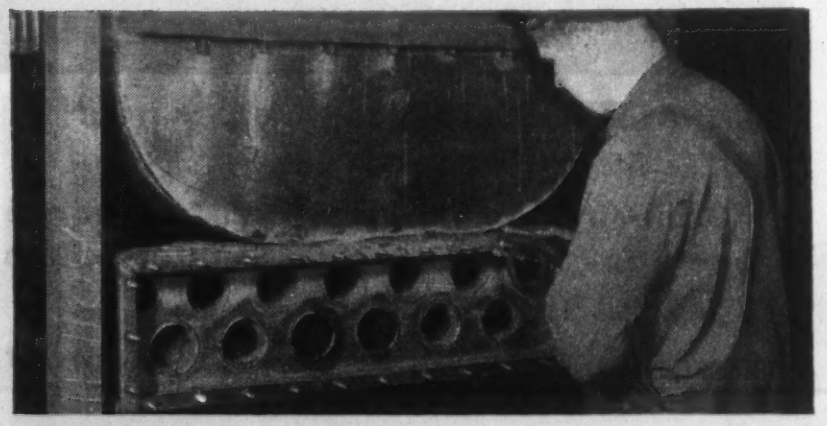
Eliminate drilling and tapping studs with NELSON STUD WELDING!

Nelson Stud Welding saves time and material because studs are end-welded to metal without drilling or tapping to secure them. Uniform welds, with full fillet, result every time . . . complete fusion between the stud and metal is obtained in ½ second.

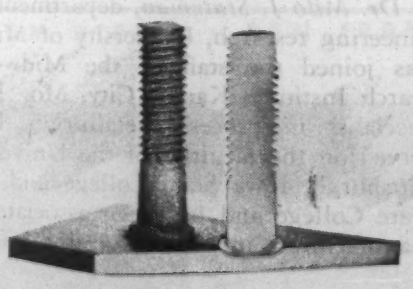
The Nelson Stud Welder is *fully automatic* and completely portable. Light in weight and easy to use, it welds effectively in any position. Or it may be operated as a production unit from a fixed jig. Thousands of these automatic welders are now being used in more than 650 industrial plants. No previous welding experience is necessary.

Write today for complete details about the Nelson Stud Welder, catalog and price list.

After layout and centerpunching the studs are welded to the metal. The stud is inserted in the gun chuck, the trigger pulled and a complete, full-fillet weld results. Operators can weld from 500 to 1500 studs in eight hours without difficulty. A template may be used if desired.



Inspection covers are an excellent application for stud welding because the studs are easily and accurately located without drilling and tapping. Welds are as strong as those made by any other method.



Cutaway view of stud after welding and etching with Nital shows the complete fusion of the stud to metal. Fillet is not only around outer surface of the stud but weld is a complete fusion of the stud to metal.

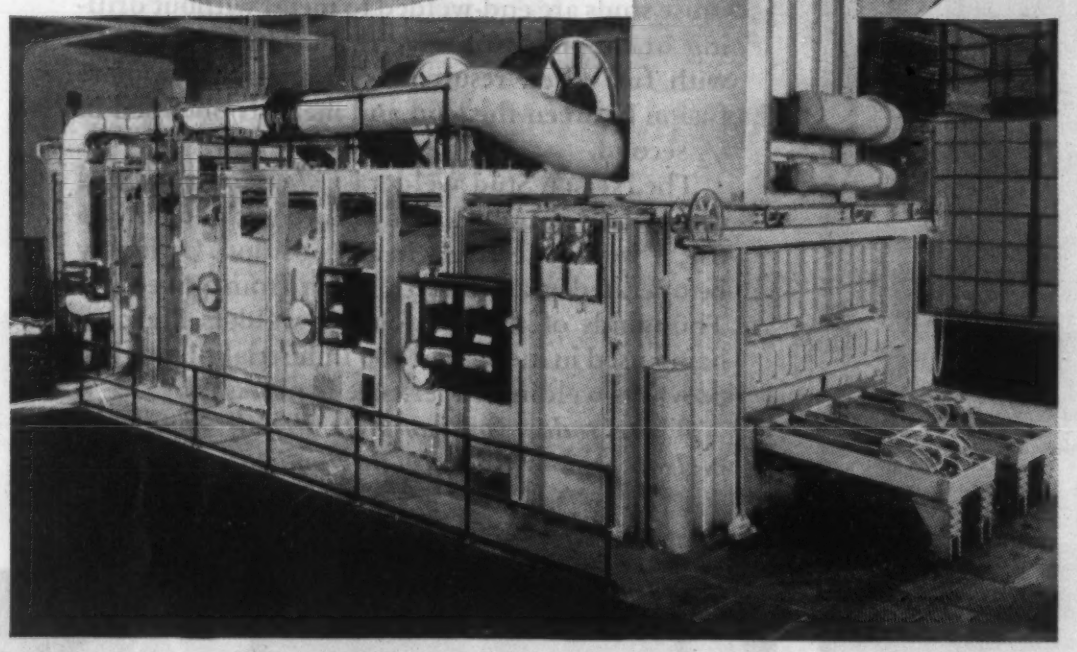
For complete details, prices and catalog write:

NELSON SPECIALTY WELDING EQUIPMENT CORP.
Dept. MA, 440 Peralta Ave., San Leandro, Calif.

Eastern Representative: Camden Stud Welding Corp.
Dept. 122, 1416 South Sixth Street, Camden, N. J.

Continuous...

COPPER WIRE BAR FURNACE



CAPACITY: 60,000 pounds per hour
SIZE: 12′3″ wide, 38′ long
10 oil-fired burners; five at discharge end above billets and five under billets
TEMPERATURE: 1700°F.
Hydraulic pushers. Recuperator to heat air
Automatic temperature control

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R-S Furnaces of Distinction

FURNACE DIVISION
R-S PRODUCTS CORPORATION

4522 Germantown Avenue • Philadelphia 44, Penna.

BUY WAR BONDS

● A new method of masking name and instruction plates has been developed by *Avery Adhesives,* 451-453 E. Third St., Los Angeles 13. These "Kum-Kleen masking stickers" are available die-cut to the exact specifications of the manufacturer. The name plate is attached to the product on the production line, covered with this sticker, then painted or finished. They are applied without moistening, stick to any smooth surface, are not affected by heat or cold, and easily peel off without leaving a trace.

News of Engineers

Dr. Gunther Mohling, scientist with the Allegheny Ludlum Steel Corp., has been presented with a cash award and certificate of appreciation by the directors for his contribution in the development of a series of high temperature alloys, one of which provides a vital link in American jet propulsion aircraft.

Henry S. Freynik has been elevated to chief metallurgist of the Riverside Metal Co., Riverside, N. J., having been associated with the laboratories of the company for 21 years.

John L. Young fills the newly-created position of vice president in charge of engineering of the National Tube Co., having been vice president of industrial research and development of the United Engineering & Foundry Co., Pittsburgh. Previous connections involved Timken Roller Bearing Co. and the D.P.C. aluminum rolling mill at Trentwood, Wash.

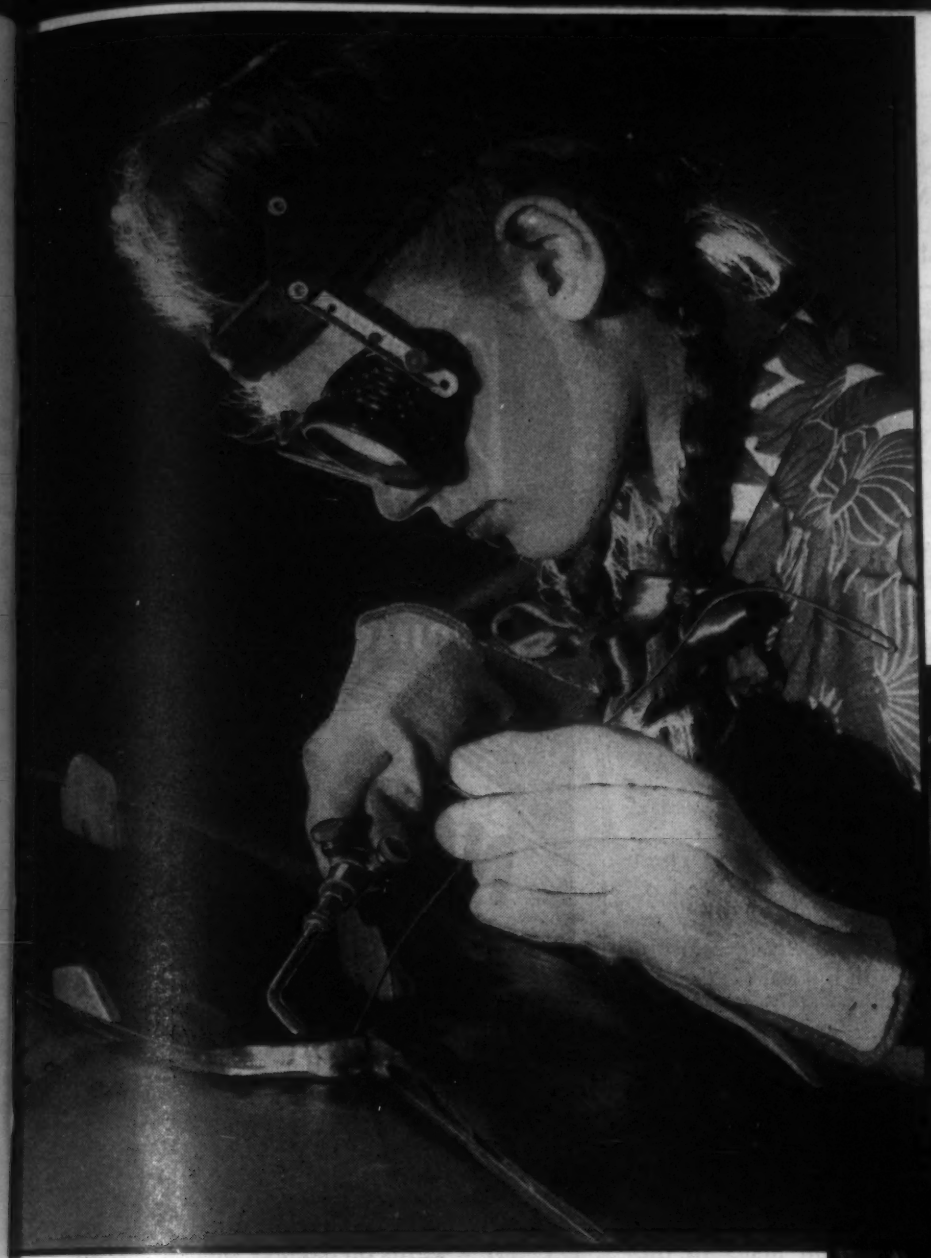
James Edward Campbell, formerly with General Motors research laboratories, Detroit, has joined the division of physical metallurgy, Battelle Memorial Institute. *Dr. Robert C. McMaster,* formerly with the electrical engineering staff, California Inst. of Technology, has joined the division of industrial physics. He belongs to several technical societies involving welding, X-rays, etc.

Lorin L. Ferral has been appointed metallurgical director of the Crucible Steel Co. of America.

Dr. Milo J. Stutzman, department of engineering research, University of Michigan, has joined the staff of the Midwest Research Institute, Kansas City, Mo. He is a specialist in process metallurgy. He has served on the faculties of the University of Pittsburgh, Iowa State College and Kansas State College and has been associated with manufacturers in metallurgical research.

Theodore A. Havens, Jr. is now tungsten engineer of the Wickwire Spencer Metallurgical Corp., having previously been with the Westinghouse Lamp Div. He has specialized in tungsten development and manufacture.

Ross H. McMaster, president, Steel Co.



How 90 = 1000 = 2200

ere is another typical equation of American genuity and skill. Welded auxiliary drop tanks, ach weighing 90 lbs. when empty, an even half n when full, and giving our famous P-38 Light- ngs and P-47 Thunderbolts a ferrying range of 200 miles—enough to cross the Atlantic Ocean.

d we take pride that Weber owcase Company of Los Angeles also among the great War Pro- uction leaders who have chosen ICTOR welding equipment.

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POWDER METALLURGY

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Hudson Run Road
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of Canada, Ltd., is named chairman, while *H. G. Hilton,* executive vice president, becomes president. Mr. Hilton started at the blast furnaces of Pickands Mather & Co. and continued a blast furnace specialist.

Earl W. Pierce has been elected chief metallurgist of Carnegie-Illinois Steel Corp., having been assistant to the general superintendent and starting as metallurgist in the plant laboratory. *Tom J. Peters* is made assistant to the general superintendent at the S. Chicago plant, where he started as testing engineer in the electrical department. His last position was assistant superintendent of the maintenance division.

C. E. Mason has been made technical director, Bristol Co., Waterbury, Conn., maker of automatic control and recording instruments. He has written many papers on automatic control and belongs to several technical societies.

Robert E. Cramer has been named chief engineer of the American Steel & Wire Co., succeeding *E. J. Reardon* who recently resigned. He has been with U. S. Steel subsidiaries for 35 years, with a wide experience in various steel plant engineering phases.

Gorham W. Woods has joined Lincoln Electric Co. as research engineer, majoring in development of electrodes. When with the Hughes Tool Co., Houston, Tex., his duties included the design, manufacture and use of oil field tools and supervision of work in various steel mills and oil fields in the Southwest and Mexico.

John A. Comstock has been made director of research and metallurgy for all divisions of H. K. Porter Co., Inc., with his headquarters at Pittsburgh. He will develop new and improved products. Previously he was engineering metallurgist with the United Aircraft Corp., East Hartford, Conn.

Dr. Harry Whittaker, diamond expert and crystallographer, has been made research head of the Koebel Diamond Tool Co., Detroit. At the same time he will continue research begun for the National Academy of Science. His research has saved millions of dollars and conserved the critical industrial diamond supply by making lower grade stores available, and lengthening the life of diamond tools.

Tracy V. Buckwalter, for 25 years chief engineer and vice president, Timken Roller Bearing Co., has retired from active work, but will serve as consultant. He developed large bearings for rolling mills, increasing output many fold; also for railroad car journals; he sponsored large fatigue testing machinery. He has written many technical articles. *O. J. Horger,* formerly in charge of railway engineering and research, has been made chief engineer of the railway division. *Albert L. Bergstrom* becomes vice president of all engineering. He had previously been chief works engineer and executive engineer. *C. L. Eastburg* has been made assistant chief engineer, railway division. *P. C. Paterson* becomes service manager of the railway division.

(Continued on page 1790)

metal parts in NOX-RUST PEEL FILM. Dries quickly into a rubbery, plastic coating. Moisture can't penetrate. And cushiony PEEL FILM wards off damage from banging or scratching. Full protection.

PEEL FILM STRIPS OFF

The metal product emerges bright and shiny as the day it was immersed in PEEL FILM—free of rust; free of nicks or scratches.

PEEL NOX-RUST FILM
The Master RUST PREVENTIVE

NOX-RUST is available in many forms for varying requirements. PEEL FILM is the newest sensation in the big NOX-RUST family. Send today for a

Free Sample

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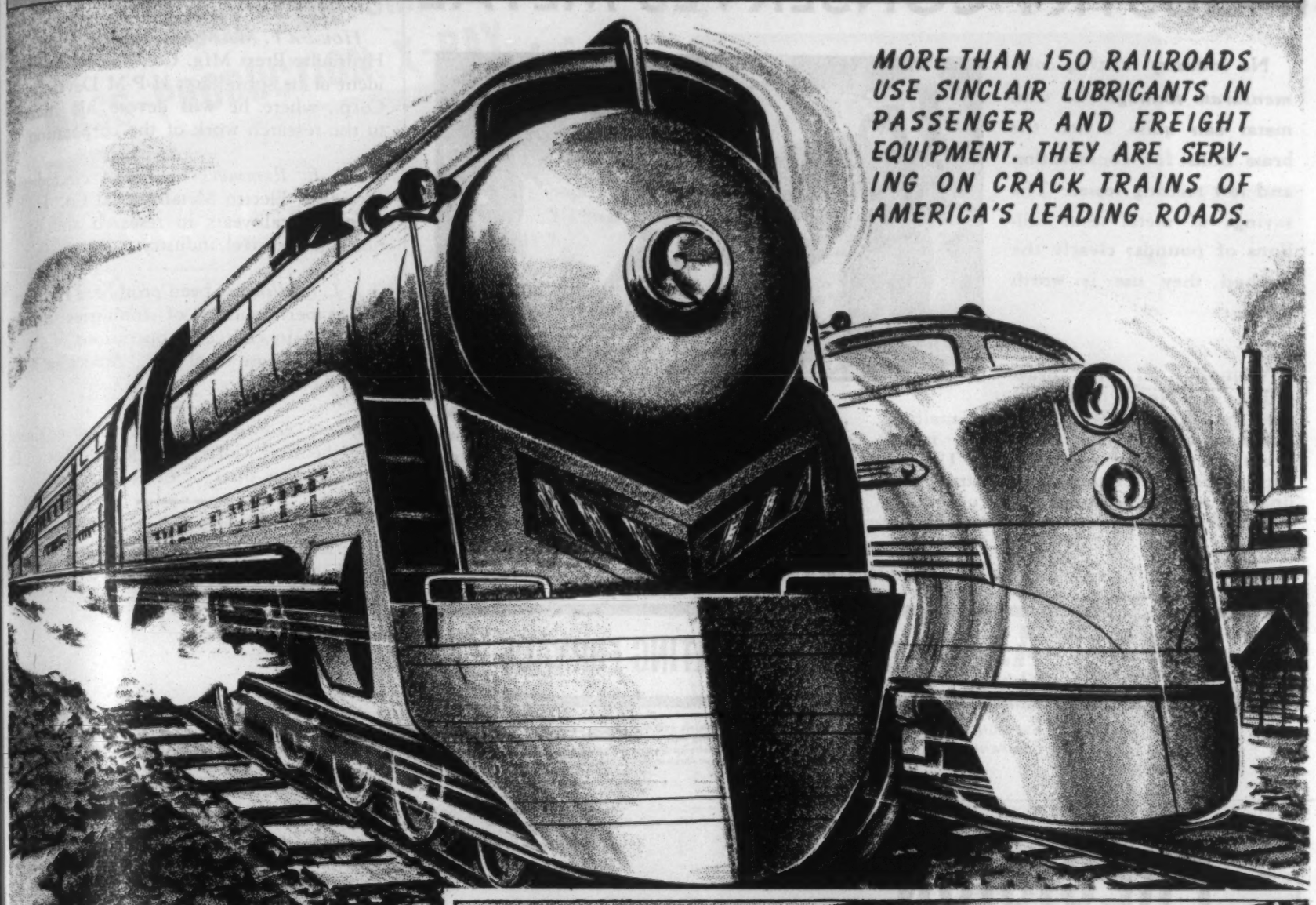
Do you know that . . .



MORE THAN 150 RAILROADS USE SINCLAIR LUBRICANTS IN PASSENGER AND FREIGHT EQUIPMENT. THEY ARE SERVING ON CRACK TRAINS OF AMERICA'S LEADING ROADS.

BETTER LUBRICATION OF MACHINING EQUIPMENT IS PROVIDED BY SINCLAIR SPECIALIZED OILS... LOW COST, FASTER HIGH PRECISION MACHINING IS PROMOTED BY SINCLAIR CUTTING OILS AND SOLVENTS.

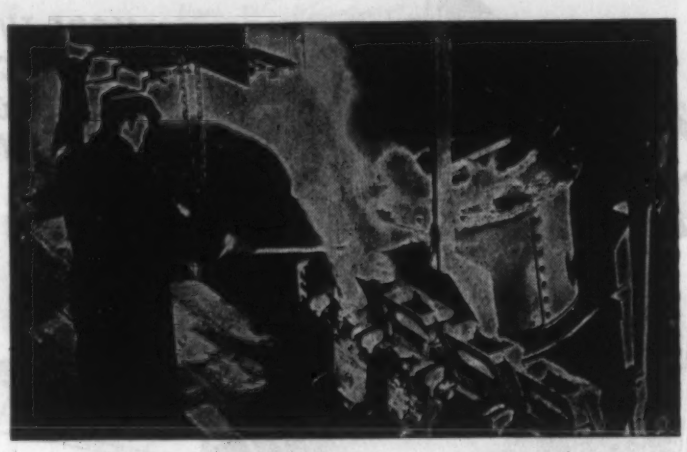
CHICAGO AND SOUTHERN AIR LINES WHICH HAS INAUGURATED AN ADDITIONAL DETROIT-HOUSTON-NEW ORLEANS DAILY SERVICE WITH NINE INTER-CITY SCHEDULED STOPS HAS FLOWN ITS FLEET OF DIXIELINERS MORE THAN 18,600,000 REVENUE MILES ON SINCLAIR PENNSYLVANIA MOTOR OIL.

SINCLAIR *IS EQUIPPED TO SERVE YOU BETTER!*

FOR FULL INFORMATION OR LUBRICATION COUNSEL WRITE SINCLAIR REFINING COMPANY, 630 FIFTH AVENUE, NEW YORK 20, N. Y.

HOW THE WROUGHT BRASS INDUSTRY CONSERVES METAL

No industry melting *commensurate tonnage of vital metal can quite match the brass mills for conservation and low melting losses. The savings of metal total millions of pounds; clearly the method they use is worth noting:**



Virtually all the brass mills in North America use the Ajax-Wyatt induction melting furnace, for it has the lowest metal losses in the field — less than 1% — with superior temperature control and unapproached economy of operation on high production schedules such as we have today.

Do you have your copy of "AJAX-METELECTRIC PROGRESS," the news magazine of induction melting, electric heat treating, non-ferrous ingot and alloys? Write to: AJAX ELECTRIC FURNACE CORP., 1108 Frankford Avenue, Philadelphia 23, Pa.

* UPWARDS OF 5 BILLION POUNDS ANNUALLY

THE AJAX WYATT INDUCTION MELTING FURNACE

ASSOCIATE COMPANIES: AJAX METAL COMPANY, *Non-Ferrous Ingot Metals and Alloys for Foundry Use*
AJAX ELECTROTHERMIC CORPORATION, *Ajax-Northrup High Frequency Induction Furnaces*
AJAX ELECTRIC COMPANY, INC., *The Ajax-Hultgren Electric Salt Bath Furnace*
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PRECISION CASTING EQUIPMENT AND SUPPLIES

For Complete Installations
Lost Wax—Investment Molding Process

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CENTRIFUGAL CASTING MACHINES
METAL MOLD EQUIPMENT
WAX INJECTION MACHINES
VACUUM PUMP UNITS
WAX ELIMINATOR OVENS
FURNACES — GAS FIRED & INDUCTION
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AND ALL RELATED SUPPLIES

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Successor to J. Goebel & Co. — Est. 1865
95 BEDFORD ST., NEW YORK CITY 14

Norbert K. Koebel, for five years director of research for Lindberg Engineering Co., Chicago, has been made manager of sales. He is author of a book and numerous articles on controlled atmosphere heat treating.

Howard F. MacMillin, formerly president, Hydraulic Press Mfg. Co., has become president of its subsidiary, H-P-M Development Corp., where he will devote his attention to the research work of the corporation.

W. E. Remmers has been elected vice president, Electro Metallurgical Co. He has spent several years in research and operations in the steel industry.

J. L. Mullin has been promoted from general superintendent of foundries to vice president in charge of operations of American Manganese Steel Div., American Brake Shoe Co.

David Gordon, recently chief engineer, Interchemical Corp., has joined Foster D. Snell, Inc. as director of engineering.

Dr. E. W. Engle, research and consulting metallurgist, Carboloy, Inc., Detroit, died April 26 after a several months' illness.

House Organ Notes

D-H Alloy Craftsman, Driver-Harris Co., Vol. V, No. 1.

Under the heading, "Nichrome Darning Needle Mends Broken Bomber Noses" we read: "At the Alameda, Cal. Naval Air Base is one of the most unusual operations to come out of this war. When cracks or other flaws show up in the plexiglas domes and surfaces of bombing planes, a small Nichrome wire, a Driver-Harris alloy, is inserted in the crack and both ends connected to electrodes. A low-voltage current is then turned on and the wire drawn along the crack. The plexiglas welds immediately behind the wire. At the crack end, one electrode is disconnected and the wire drawn out. A low current leaves only a little flash, easily removed, while a higher heat, though faster, leaves small bubbles in the weld."

The Continental, Continental Foundry & Machine Co., March, 1945.

Tank warfare is a relatively recent tactical operation. Most changes in tank design were made of necessity. Back in 1931 little thought was given to heavy armor. Even modern machine gun fire could destroy such a tank. Even in 1936 castings played only a minor role. Automobile springs on lower wheels were completely exposed. Most revolutionary changes made to date have been streamlining of the tanks, lowering of their silhouette, increasing of the armament and permitting the turret to revolve 360 deg.

The Kellogram, M. W. Kellogg Co., 19[illegible] Series, No. 2.

The leading article, "Metallurgy, the S[illegible]

A NEW TOOL FOR SMALL-LOT OR MASS-PRODUCTION X-RAY . . . . *The Productograph*

A PACKAGED UNIT THAT ELIMINATES LEAD-LINED ROOMS, CONSERVES OPERATOR'S TIME

Here's new help for industrial x-ray. Available for 150 or 220-kv operation, the Westinghouse Productograph speeds inspection for both small-lot and mass-production products.

This compact unit can be installed by the production line itself, eliminating expensive, lead-lined rooms and conserving operator's time in making x-rays. Time can then be utilized to prepare additional specimen for radiography. Traffic to lead-lined room is eliminated. Exposures can be either automatic or manual, depending upon the type and size of products to be inspected.

Where automatic control can be used, the technician need only determine the kilovoltage and time settings, place the tray into the unit and push the starter. Exposure is then made automatically. Easily-operated manual controls make the operation fast and accurate for small-lot inspections.

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CERROMATRIX (Melting Temp. 250°F.) For securing punch and die parts, anchoring machine parts without expensive drive fits, short run forming dies and other metal-working applications.

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lent Partner in Successful Oil Refining," points out that in early refining units (1914) temperatures rarely ranged over 700 F. and pressures varied from atmospheric to a top of 500 lb. Today temperatures up to 1200 F. and pressures to 2000 lb. are common in oil refineries. Riveting, the accepted method of fabrication of vessels in the early days proved unsuited, so in 1914 Kellogg introduced hammer welding. But this involved tremendous outlays for hammer welding equipment and it was unsuitable for field fabrication. So eventually they turned to electrical welding and developed coated rods, the latter protecting molten metal from reacting with oxygen and nitrogen from the air, giving sounder weld metal. Now Kellogg is pioneering with submerged arc welding which permits a deposit of metal 1½ in. thick in a weld with a single pass operation instead of 12 to 18 passes. One of the problems solved was finding equipment to withstand excessive corrosive action of ortho-phosphoric acid. The alloy hit upon was 18% chromium, 8% nickel, 3% molybdenum and a little columbium.

Wheelabrator Digest, American Foundry Equipment Co., Winter, 1945.

The first sheet metal lifeboat was invented in 1838 and perfected in 1847 by Joseph Francis, native of Massachusetts. He was jeered by his friends because "iron does not float." The final product was called "Corrugated Galvanized Iron Life-Car." With his original dies the sheet iron invariably sprang back to its original flat shape, but eventually he perfected crudely satisfactory concave and convex dies. His "life car" was sent to the New Jersey coast where it waited two years to prove itself. In 1850 the British ship, "Ayrshire" foundered and the "life car" saved 200 passengers and crew.

Private Wire, American Brake Shoe Co., No. 10.

Five dollars' worth of iron made into horseshoes has a market value of $10. Converted into needles, it becomes worth $6,800. When made into hairsprings of watches it has a value of $2,000,000.

Nickel Cast Iron News, International Nickel Co., Inc., Second Quarter, 1945.

Considerable to-do was raised in the foundry industry by a reference in *Reader's Digest* by the well known author, Louis Bromfield, to "mere" cast iron. The Gray Iron Founders' Society took Mr. Bromfield to task and he has replied as follows: "I have no doubt that cast iron is extremely useful and valuable for certain purposes and plays a great role in our modern life. I do know from my own experience, accompanied by a great deal of swearing, that I prefer alloy steel to materials which break and bend when put under sufficient strain. I have myself experienced these breakages while using farm implements in the field. I apologize if I have made any error through ignorance but I stick to my point that, whatever the materials used in much of the farm machinery manufactured today, there is an urgent need for the employment of material of better quality for the purpose involved."

A NEW NAME TO REMEMBER
WHEN YOU THINK OF
ACID- and Alkali-PROOF CEMENTS

POROSITY LESS THAN ½ OF 1% • HIGH COMPRESSIVE AND TENSILE STRENGTH
RESISTANT TO ACIDS, ALKALIES AND SOLVENTS • QUICK SETTING • NON-TOXIC

DURISITE is a resinous cement with important *new* properties. Unlike most resinous cements it is completely stable in storage. You can carry supplies on hand ready for use when needed. No vexatious delays while orders clear. No costly waste from deterioration in storage. And, unlike most resinous cements, Durisite is non-toxic. Durisite has no dangerous effect on the skin.

Durisite will handle most acids (including hydrofluoric in all concentrations), alkalies of any degree of strength, all oils and solvents, at temperatures up to 350°-375° F. It will handle strong acids and alkalies alternately. Durisite is a cement of unusual strength (compressive and tensile strength is approximately four times that of silicate-type cements). Durisite's dense, non-porous structure is permanent, remaining completely non-absorbent and impermeable even at elevated temperatures.

Durisite is a quick-setting cement. Brick can be laid as fast as the workmen can handle them, course upon course, with no danger of the mortar being squeezed out from the lower courses.

Time proven in extensive laboratory and field tests over a period of three years, Durisite is setting new records for durability in tough *acid-and-alkali-proof* masonry construction.

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Dense, non-porous, and non-absorbent body. Accurately shaped, extremely hard and durable. Acid- and - corrosion - proof all the way through. Available in both the 8″ and 9″ series of standard sizes and shapes. Special sizes and shapes on order.

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ACID-PROOF CEMENTS INCLUDE:

"Vitric-10"—a quick-setting, chemical-hardening sodium silicate cement. Inert to all acids (except hydrofluoric), and solvents. Not resistant to alkalies.

"Super-Vitric"—for use with strong acids only.

"Pre-Mixt"—a silicate-type cement requiring only the addition of water.

"Portite"—heat-and-pour sulphur base cement, sets in five minutes to a dense, impermeable body. Suitable for temperatures up to 200° F.

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The Mainspring, Wallace Barnes Co., April, 1945—"Spring No. 10, Coil No. 12."

"If any of our grandchildren may ask us (when old enough to talk) 'What's an engineer, Gramp?' we now have a better assortment of answers on tap. In requests for the recent handbook, 'Mechanical Springs,' engineers qualified their status with the following prefixes: Aerodynamic, aeronautical, chief, electrical, equipment, experimental, process, product, production, professional, project, research, stress, and X-ray. Being a 'Gramp,' however, we'll probably rely on the time-honored description of that glamorous guy who runs the railroad engines."

Folks, General Motors Corp., May, 1945.

The following is an interesting introduction to an article on "From Thumbnails to Air Gages" by H. J. Havermale. "Inspection is based largely on measuring things. To do this we must have units of measurement. It is interesting to look at what history tells us about such units.

"We know that the Pyramids, which are about 4,000 years old, were built with some definite system of measurement. It probably was the cubit, which was the length of the human forearm. But since all men were not exactly the same size, the cubit had a way of varying. However, it finally became standard, but in two forms: the Royal Egyptian, about 20.62 in. long and the Greek Olympic cubit of 18.24 in. Later on, two-thirds of the cubit became the foot, which in turn was divided into 12 thumbnail-breadths, or inches.

"To the best of our knowledge no further progress was made toward a definite standard of measurement until 1324 when Edward II of England decreed that the inch would be the length of three barley-corns taken from the middle of the ear and placed end to end. Until the meter was established some 500 years later, this was the only standard of length that did not originate in some part of the human body.

"Even the fathom was the span of a man's outstretched arms. In the 16th century the lawful rod in England was the total length of the left feet of the first 16 men who came out of church on Sunday morning. We still have a 16-ft. rod but we don't measure the left feet of the first 16 men who come out of church on Sunday morning to find out how long the rod will be for this week."

Plants and Slants

One of the adventure stories of war production was brought out in connection with the award of the fourth star in the Army-Navy "E" flag to *Zenith Optical, Div.* of *Polan Industries,* Huntington, W. Va. The five Polan brothers, sons of an oculist, began to experiment with optical glass in 1932. After five years they had a small plant where they upset various ancient taboos in the manufacture of spectacle lenses. In 1937 flood waters from the Ohio hit the white hot glass furnace and the

All are **C-F POSITIONERS**

2500 lbs. 6000 lbs. 6000 lbs.

Modern welding specifications call for "positioned welding throughout," and today in all parts of the country, we find endless streams of war materials coming off production lines of C-F Welding Positioners. Some of these lines are blocks long and made up of identical positioners on each of which is built a complete unit. In others like the 3 positioner sub-assembly line the C-F Positioners are progressively larger as the weldment increases in size and weight.

In planning your post war set-up, remember that there is a C-F Positioner exactly suited to every requirement, that each is a universal tool, operated by the welder himself by push button or hand wheel control, that are all adjustable for height, all rotate a full 360°, all tilt 135° beyond horizontal.

other C-F Positioner capacities:
1,200 lb.
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20,000 lb.
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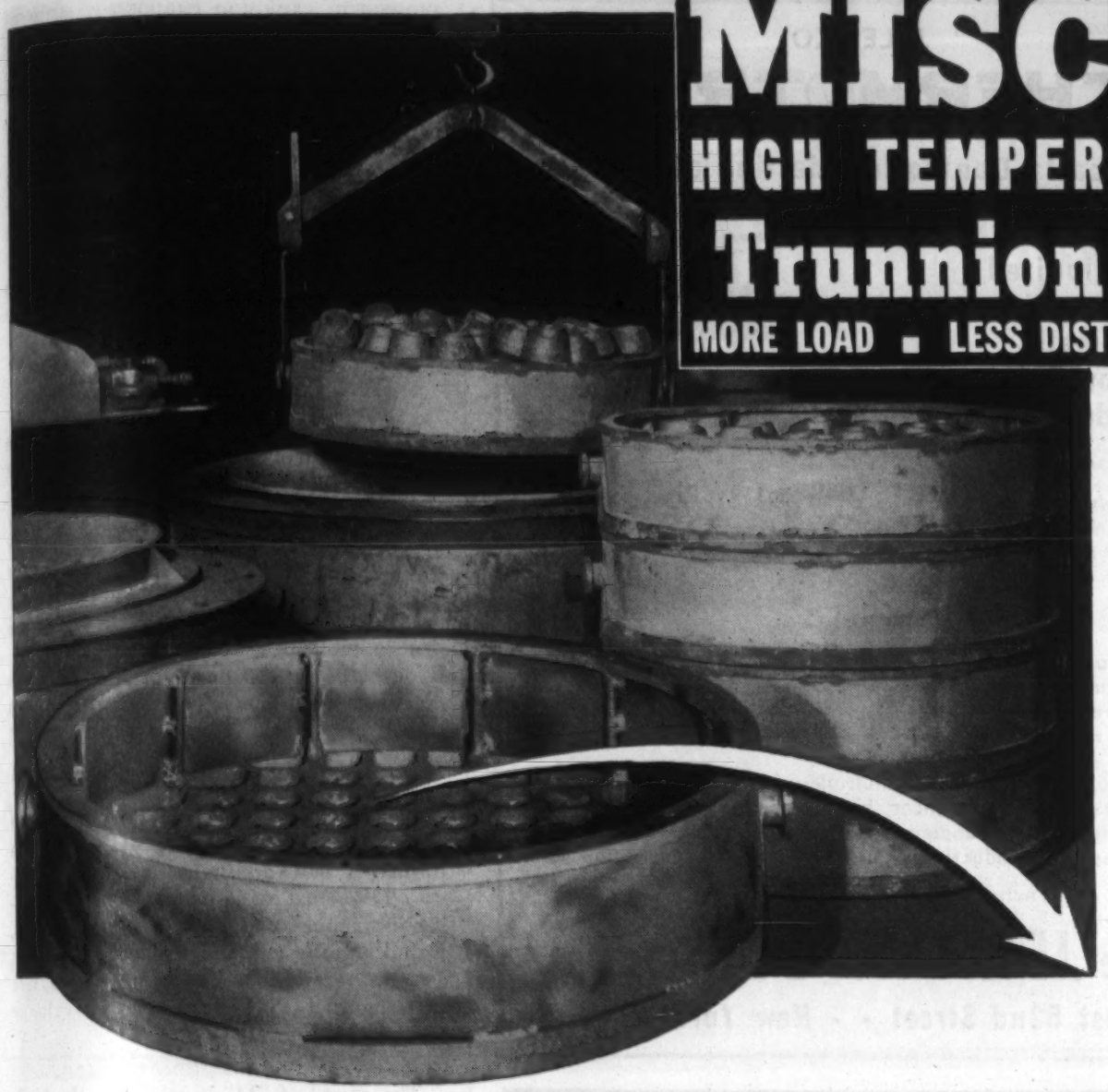
HIGH TEMPERATURE ALLOY

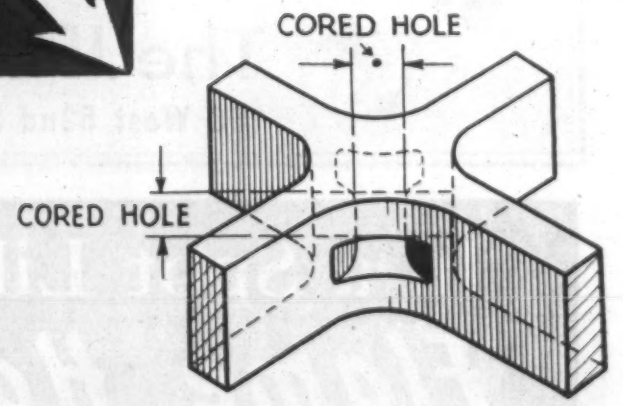
Trunnion Baskets

MORE LOAD ■ LESS DISTORTION ■ LONGER LIFE



MISCO PATENTED GRID INTERSECTIONS

Shrinkage cavities are avoided by coring grid bar intersections horizontally and diagonally. Metal thus saved in regions of low stress is added in areas of high stress where it increases load capacity, reduces distortion and gives longer life.



To help do your job more effectively and in the most economical manner, Misco offers complete facilities for producing heat treating equipment in cast and rolled alloys. Produced in a variety of analyses to suit every practical condition, the construction of Misco Alloy Products can be varied to suit operating demands, whether the duty is normal or extremely severe.

The illustration shows a group of Misco trunnion baskets designed to stack five high in a pit type furnace. Each tier is 45″ in diameter by 10″ deep and carries 1800 pounds of work at 1700° F. Sections are lifted individually with full load at maximum temperature. Bottom grid and top ring are Misco Metal castings. Vertical posts and sheet sides are rolled Misco alloy.

You are invited to consult with us on any high temperature problem. We offer practical, reliable service based on many years experience in this field and we are glad to help.

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FURNACE PARTS • ROLLER RAILS • ROLLER HEARTHS • CONVEYOR ROLLS • TRAYS • RETORTS • CHAIN • MUFFLES WALKING BEAM CONVEYORS • CARBURIZING AND ANNEALING BOXES • DIPPING BASKETS • CYANIDE AND LEAD POTS • THERMOCOUPLE PROTECTION TUBES • PICKLING EQUIPMENT • CENTRIFUGAL CASTINGS • MISCELLANEOUS CASTINGS AND ROLLED BARS • SHEETS, PLATES, TUBES AND WELDING WIRE FOR USE AT HIGH TEMPERATURE OR UNDER CORROSIVE CONDITIONS.

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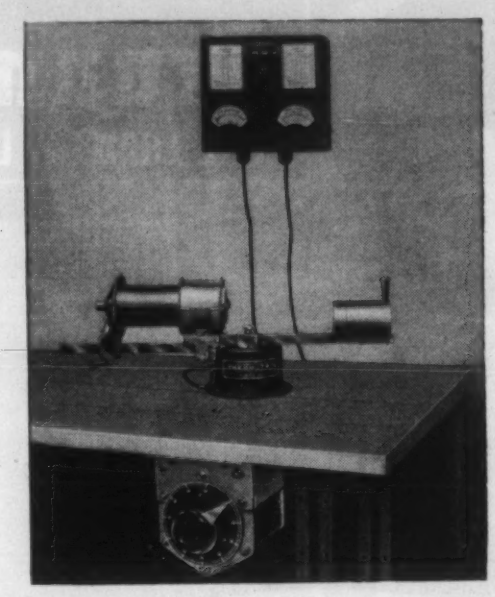
Electrically Controlled Melting and Casting

It has Revolutionized the Production of Small Precision Parts in Industry

Now widely used by important war industries and by manufacturing jewelers.

for Casting non-ferrous metals and their alloys; gold, silver, etc.



"Thermotrol" makes possible multiple casting of small precision parts to micrometer tolerances, largely eliminating machining operations and greatly reducing finishing. Minimum skill required to operate. Speeds production. Cuts costs, rejects and scrap loss.

Technical Literature on request.

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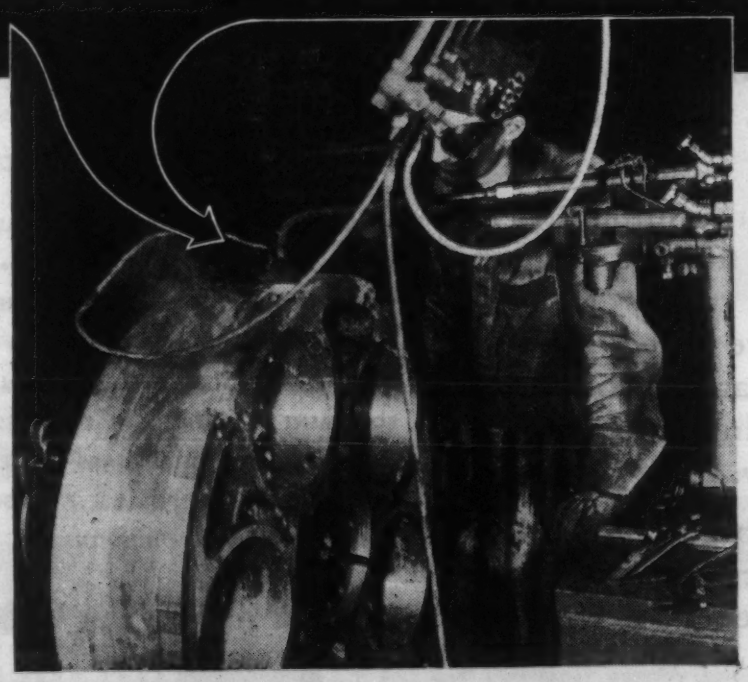

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subsequent explosion temporarily shattered Polan ambitions. Came the war, when America doubted that precision optics, accurate to a half millionth of an inch, could be made outside the great Zeiss works. Over night the Polans gathered road workers, mountaineers and farm women and taught them to manufacture precision optical equipment. The training period was cut from four to six years to so many months. Their lenses allowed the Navy range finders to sight a spot on the mast of an enemy ship 10 miles away and give the distance accurately to a fraction of an inch.

The *Republic Mining & Mfg. Co.* has changed its name to *Alcoa Mining Co.* to identify the company more closely with *Aluminum Co. of America.* The company has been associated with American bauxite mining for more than a half century. It has been a 100% subsidiary of the present parent company since 1909 and was the first to mine bauxite in the United States. It developed the nation's principal bauxite deposits in Arkansas, which it has mined since 1899. During this war it has produced ore at a rate of 15 times that of 1939.

United States Vanadium Corp., unit of *Union Carbide and Carbon Corp.*, has formed a new division, the *Metal Chemicals Div.*, that will manufacture and market inorganic compounds of certain metals, including tungsten, molybdenum, vanadium, etc. J. A. Holliday has been elected vice president of U. S. Vanadium and has charge of the new division.

The award of "M" pennants by the U. S. Maritime Commission was abandoned on March 31, 1945, it was announced in connection with the award of another gold star to the *Edward Valve & Mfg. Co., Inc.*, E. Chicago, Ind., maker of cast and forged valves. In all, less than 200 "M" pennants have been awarded to shipyards and key manufacturing plants.

Another device to recognize the "soldier on the production front" is that taken by the *Lawrence Aeronautical Corp.*, Linden, N. J., who gives each employee working on war production a large "Certificate of Service in War Work," with name filled in and ready for framing.

The *Shearcut Tool Co.*, formerly of Beverly Hills, Calif., has moved to Bellingham, Wash., because of the critical labor shortage in Southern California. At the same time they announce a new type of boring and cutting tool holder for use with their own tools.

All New York City offices of *Surface Combustion Corp.*, Toledo, Ohio, have been consolidated at 315 Transportation Bldg., 225 Broadway, New York 7.

The *Columbia Machine Works, Inc.*, has recently been acquired as a subsidiary, by *Maguire Industries, Inc.* Columbia is a 53-year old company making centrifuges, electronic equipment and castings. Maguire, originally maker of Thompson submachine guns, has expanded into the electronic, radio and other fields.

MORE than five times the size of an ordinary fire brick, yet it weighs practically the same! That in a few words tells the story behind the installation economies of J-M Insulating Fireblok.

Lightness speeds work—You can see immediately what the light weight of these large-size units means in terms of labor economy . . . speedier installation.

Easily cut and fitted—J-M Insulating Fireblok can be cut with a saw, shaped with a rasp, or drilled . . . and easily fitted into irregular positions. Makes a large stock of special shapes unnecessary.

Minimum of joints—The large size of J-M Insulating Fireblok so reduces the number of joints as to materially improve the thermal efficiency of the construction.

Economical bonding — Naturally, this reduction in joint length speeds work and reduces the amount of cement needed for bonding. (J-M 1626 cement was developed especially for this use.)

Uses—Use Fireblok where Insulating Fire Brick is recommended—industrial furnaces, flues, etc. It is particularly suitable for door linings, suspended arches, and when tapered, for sprung arches of exceptional stability.

For specific temperature ranges—These block-shaped, workable insulating refractory linings come in 4 different types—the same as J-M Insulating Fire Brick. Each type was especially developed for its particular temperature range.

Fireblok is only one of many J-M Insulations for industrial use. Johns-Manville Insulations cover the full temperature range from 400° F below zero to 2600° F above. J-M's long experience and research assure you authoritative help in your insulation planning. For further information, write Johns-Manville, 22 E. 40th St., New York 16, N. Y.

Over 5 times as large as ordinary fire brick, Fireblok goes into place quickly and economically. Not only is labor time saved, but costly shut-down time is decreased.

4 Fireblok types available

JM-1620 Fireblok for exposed temp. to 1600° F. As back-up to 2000° F.

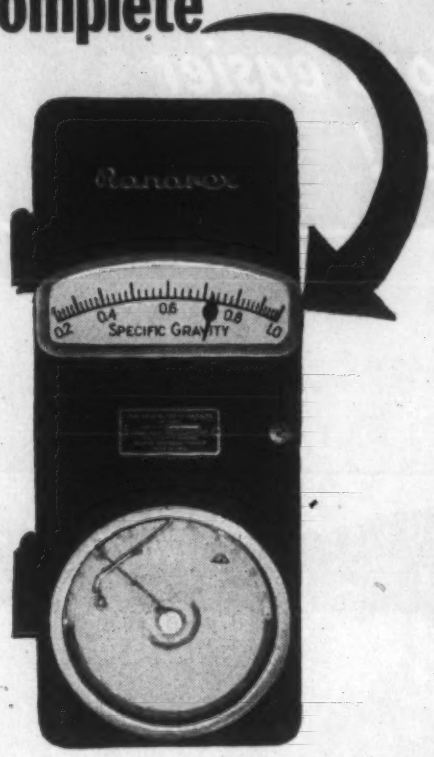
JM-20 Fireblok for use up to 2000° F. Exposed or back-up..

JM-23 Fireblok for use up to 2300° F. Exposed or back-up.

JM-26 Fireblok for use up to 2600° F. Exposed or back-up.

JOHNS-MANVILLE *First in* INSULATIONS

Instrument tells exact moment when FURNACE PURGE is complete



MEASURE specific gravity of generator gas with the Ranarex* instrument and continue purge until the specific gravity is the same at the furnace outlet as it is at the inlet. At that point you can be sure there's no air in the gas. Danger of explosion is reduced and over-purging for safety is unnecessary.

Helps control quality

Ranarex also makes it easy to maintain uniform composition. Just measure the specific gravity of the raw gas and atmosphere gas. The instrument is quick, accurate, easy to use. It contains no chemicals or fragile parts.

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PERMUTIT'S
RANAREX

Another secret engineering weapon has been revealed as spotwelding at the Willow Run plant, *Ford Motor Co.* The technique has been applied to 100 assemblies of B-24 bombers and has saved 125 man-hours per airplane, resulting in reduction in weight and halving of original costs. Aluminum and magnesium alloys and stainless steels are being welded by batteries of spot, seam and roll welding machines by employees who start spotwelding the first day on the job.

Briefs on Associations, Promotions and Education

"Behind the Annual Report" is a new motion picture translating the story of U. S. Steel for 1944 into a visual presentation of its production and the use made of funds received from sales. It employs animated graphs to tell the Corporation's financial story. Thus in one sequence five white hot steel ingots represent money it received during 1940 through 1944.

Research data of immense importance, much of which is buried in the many departments of the technical schools and universities, is being unearthed for the first time. Master theses are now being made available to industry. Information which is not easily accessible is being made available in carefully indexed form. Through the cooperation of the leading technical schools and universities, master theses that are of importance to industry and research, will be indexed in the technical "Digest-Index" issued by the National Research Bureau, Inc., 415 North Dearborn St., Chicago 10. They will be supplied on microfilm through the Library of Industrial Research, a non-profit organization, acting as clearing house for the exchange of technical, scientific and management information. Many of the leading firms in the United States and Canada are members of the library.

A professorship of light metals in the Department of Metallurgical Engineering, Carnegie Institute of Technology, is being established through a grant of $200,000 to the endowment fund made by the Aluminum Co. of America.

Publication of printed abstracts or short descriptions of 45,000 U. S. patents, seized from enemy aliens and nationals of occupied countries, available for license to American citizens, is announced by James E. Markham, Alien Property Custodian, Washington. They are divided into two groups: Chemical and Mechanical-Electrical.

A new sound film—"Carbon—Black Treasure"—has been prepared by the National Carbon Co. It is a 16-mm. Kodachrome film, timed 37 min. It depicts realistically the development and fabrication of carbon, its application to the electric arc, the manufacture of electrodes and anodes, as well as their use. A dramatic feature is an exposition of the use of carbon in actual steel

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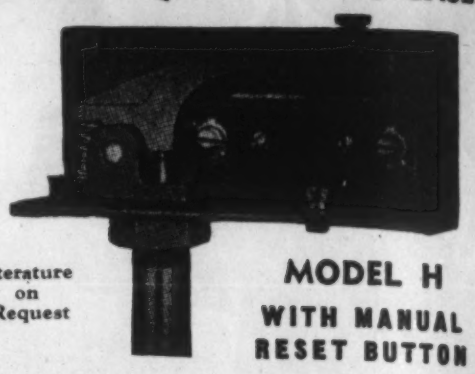
TEMPERATURE LIMIT SWITCHES

USE NO LIQUIDS . . . NO GASES



Literature on Request

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WITH MANUAL RESET BUTTON

Improved High Temperature Safety Switch with Manual Reset Button. Available with switch normally closed for cutting off heat, stopping fan, closing valve — with switch normally open for lighting lamp or ringing bell—with single pole double throw switch . . . breaks heating circuit while closing alarm circuit. Sturdy, foolproof reset button operates from outside of case.

- Accurate, Rugged, Dependable
- Corrosion and heat resisting tube
- Dial Pointer for easy setting
- Locking screw locks temperature setting
- Terminal plate has large screw terminals
- Snap-action Micro-Switch eliminates contact troubles
- Range 0-1400°F. Adjustable range 200-300°F
- Dimensions—5⅛" x 1¾" x 3"

MODEL V-I

For lower temperature range from 0-300°F. Available for minimum of —100° to maximum of 600°F. Usual adjustable range 50-150°, operating differential may be as small as ±¼ or as large as ±5°. Adjustable by screw and dial inside case. (Sizes 2¾" diameter × 4¼" high)

MODEL D

Adjustable range 200-500°F. Temperature range 0-1400°F. For use where temperature must be changed to suit operating conditions. Turn outside knob to change temperature setting. (Sizes 5½ x 2¾ x 2¾").

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ANOTHER

G-E Fully Automatic Anodizing Power Unit Installed

This large automatically controlled power unit for 5000-ampere 40-volt chromic acid anodizing was recently installed in one of our largest B-29 bomber manufacturing plants. Essentially, the unit consists of eighteen G-E "2000" large capacity copper-oxide rectifiers, a motor operated control with its accessories and an operator's panel.

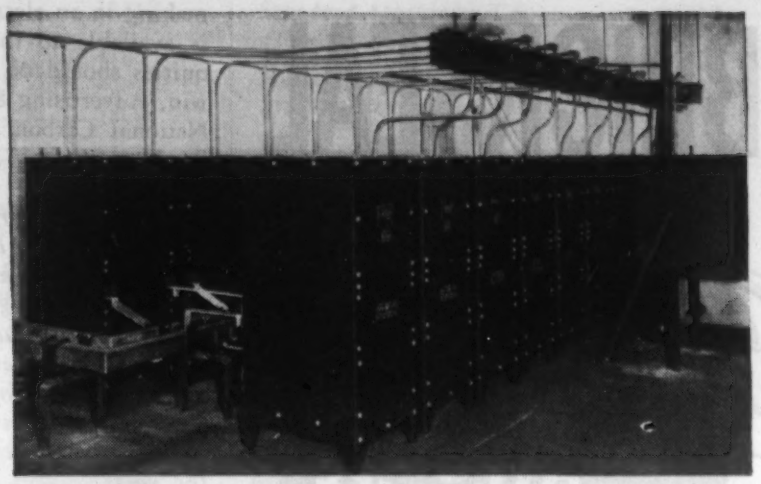
To anodize, the plater simply presses the start button on the operator's control panel. Thereafter the whole anodizing process is fully automatic. When the anodic film is formed the unit shuts off automatically and returns to starting position for the next load. No adjustment is required regardless of the size of load. Voltage build-up in relation to the formation of the film is positively controlled. All chance of overloading the equipment is eliminated. G-E fully automatic power equipment completes the anodizing in the shortest possible time.

For modern anodizing needs, select your power equipment from the G-E line. There are many different rated units from which to choose. Detailed data on request from Section A651-112, Appliance and Merchandise Dept., General Electric Company, Bridgeport, Conn. Write today.

Hear the General Electric radio programs: "The G-E All Girl Orchestra" Sunday 10 P.M. EWT, NBC. "The World Today" news Monday through Friday 6:45 P.M. EWT, CBS. "The G-E House-party" Monday through Friday 4:00 P.M. EWT, CBS.

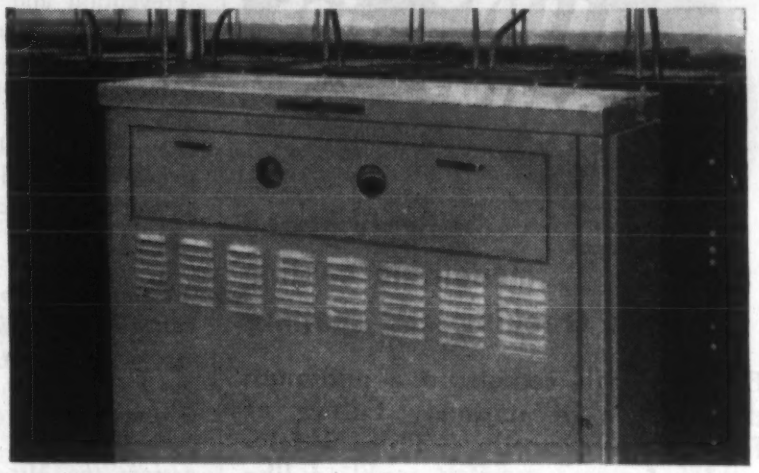
BUY WAR BONDS AND KEEP THEM

GENERAL ELECTRIC



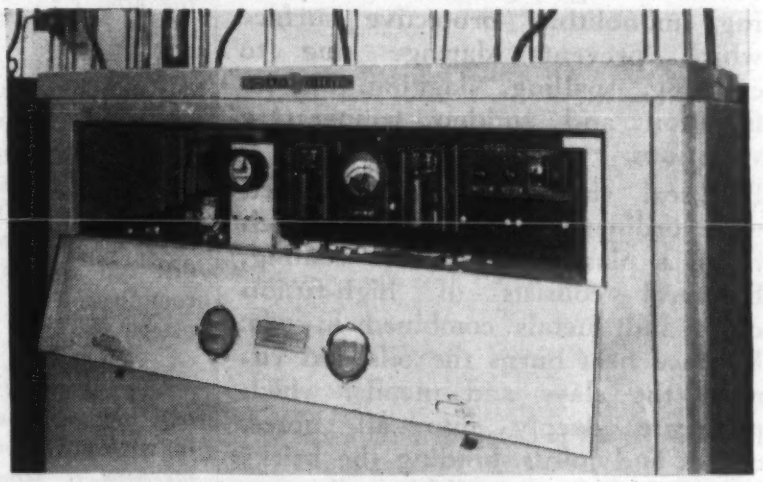
RECTIFIERS

Eighteen G-E "2000" Copper-oxide rectifiers connected in parallel provide output of 5000 amperes 40-volts d-c.



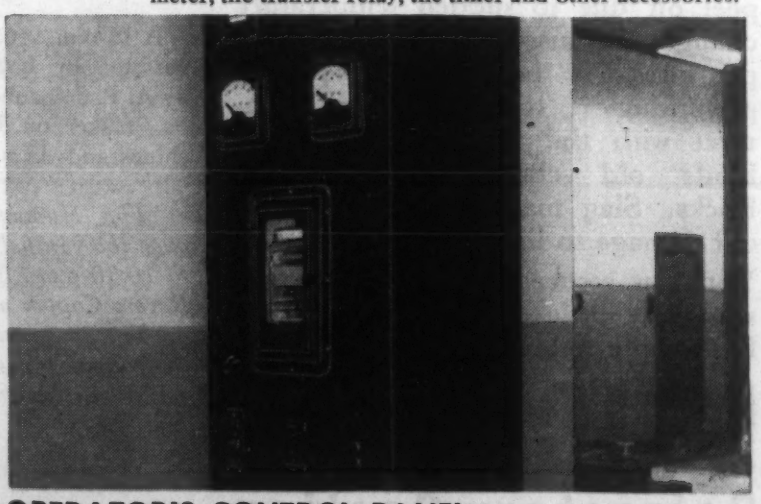
RECTIFIER CONTROL

Fully automatic, easy to use, reduces labor costs. Eliminates "human element" factor and leaves nothing to chance.



RECTIFIER CONTROL ACCESSORIES

Open view of control showing the contact-making voltmeter, the transfer relay, the timer and other accessories.



OPERATOR'S CONTROL PANEL

Located near the tanks for operator's convenience is complete with start-stop push buttons, indicating instruments, recording voltmeter, etc.

(Photographs courtesy of LaSalco Inc.)

BRICKSEAL

★Highly-glazed monolithic coating prevents cracking and spalling

Brickseal will reduce to a minimum the danger of untimely failure of furnace refractories. This widely-used refractory coating, applied like paint with brush or spray gun, forms a highly-glazed, heat-reflecting, monolithic, protective surface which prevents damage due to cracking, spalling, slagging, air infiltration and sudden temperature variations.

Brickseal should not be confused with ordinary air-set washes which form a plaster-like surface coating. Brickseal consists of high-fusion clays and metals combined in oils. Furnace heat burns the oils and vitrifies the clays and metals, which penetrate deeply into all pores, cracks and joints, binding the bricks into a durable, monolithic wall.

Brickseal cannot crack, blister or peel off due to sudden temperature changes because, at operating temperatures, it becomes semi-plastic, permitting it to expand and contract with the wall. Brickseal also binds old cracked or loosened bricks. Slag may be removed without damage to lining.

You can secure Brickseal protection with very little cost or delay. Write for sample today.

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Refractory Coating

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making in an electric arc furnace. The film is available to interested groups. All inquiries should be addressed to R. L. Baldwin, Advertising & Sales Promotion Dept., National Carbon Co., Inc., 30 East 42nd St., New York 17.

The retiring president of the American Ceramic Society, Inc. stresses the need for research work to keep the industry ahead of the times. He suggests a fund be raised to encourage the study of fundamental problems of the clay and silicate industries. He advises employment of a technical secretary to coordinate development work. He reported a 13% increase in membership over the year.

A 16-mm. sound, color motion picture, "Prevention and Control of Distortion in Arc Welding" has been sponsored by Lincoln Electric Co. It was produced by Walt Disney Productions and the "hero" of the film is "Mr. Shrink." This animated character causes much trouble but is thwarted at every turn and is even unknowingly put to work to overcome distortion in several cases.

Education programs to dramatize the post-war possibilities of magnesium are being staged by the Hills-McCanna Co., 3025 N. Western Ave., Chicago 18. The 3-part program consists of an exhibit of parts made from magnesium alloys; a sound film, "Magnesium the Miracle Metal," and talks on metallurgical aspects by Hills-McCanna executives. Interested groups may borrow the film.

The American Standards Assn. is working out a safety color code for marking physical hazards. Tentatively this is: Red for fire protection equipment, danger and "stop" signals; yellow for caution and hazards involving striking against, stumbling, falling, tripping, etc.; green for safety and site of first aid equipment; white, black, or a combination for housekeeping and traffic markings.

The American Society of Tool Engineers has selected Houston, Texas, as the place for their annual meeting in 1946. The 1945 meeting is scheduled for Pittsburgh in October, the type of meeting depending on war exigencies.

A 16-mm. sound film, "Speed in Cutting," narrated by Lowell Thomas, is sponsored by A. P. de Sanno & Son, Inc., Phoenixville, Pa., maker of Radiac abrasive cut-off machines and discs.

"The Human Adventure," now heard over the Mutual Network Wednesdays (10 to 10:30 p.m., EWT) will be sponsored by Revere Copper and Brass, Inc., starting July 4. The program is designed to popularize the romance of scientific progress, dramatizing how scientific research benefits all mankind.

The James F. Lincoln Arc Welding Foundation, Cleveland 1, has published a booklet on rules and conditions of the $20,000 award program for textbooks covering machine and structural design for modern processes, including welding. The closing date is May 15, 1946.

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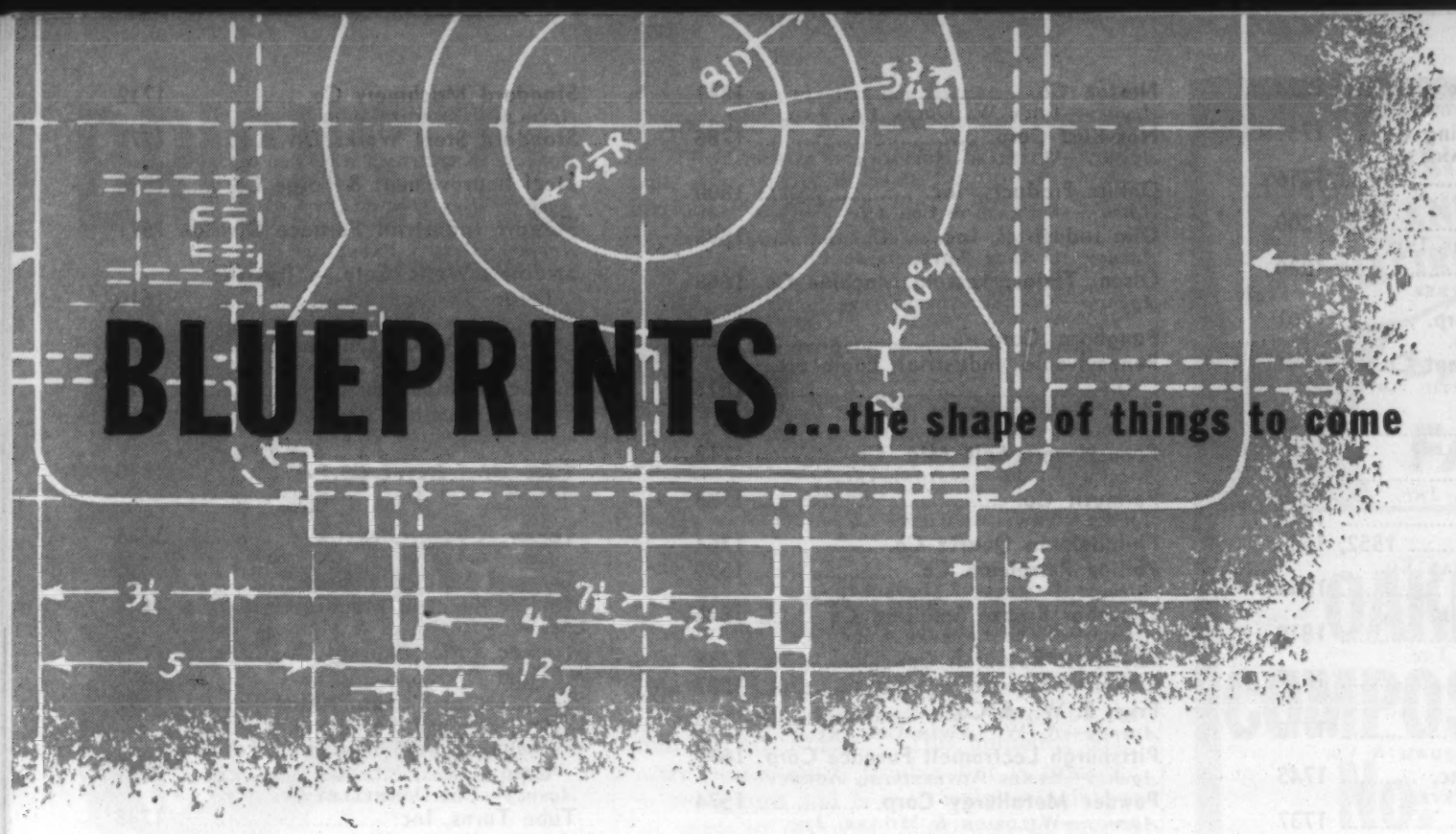


BLUEPRINTS...the shape of things to come

Boron Carbide

Among the most promising of the ultra-hard materials developed to a high degree during the war is boron carbide, now being used increasingly for plug, ring and snap gages, for dial-gage points, sand- and shot-blast nozzles, etc. The material has a Knoop indenter hardness reading of 2230, which places it between silicon carbide and diamond and makes it the hardest material commercially made by man today.

Electric Steel

Still watching statistics for clues as to post-war trends in electric steel consumption, we note that if the rate of output of electric steel ingots for the first two months (350,213 net tons per mo.) of 1945 is maintained the total this year will be larger than in 1944.

Jeeps

The fabulous jeep is going to be the ubiquitous jeep in our national post-war life. Surveys of probable applications show that it will serve in farms, industrial plants, oil fields, mining and lumber camps, railroad yards, motor freight depots, airports, maintenance of utility and transportation lines, highway patrol departments, rural mail delivery and elsewhere.

Silver Bearings

Results of more than 4,000 tests of silver bearings by a large automotive manufacturer indicate that the proper use of silver assures greater capacity and fatigue resistance than other metals in this application. Post-war automobiles will undoubtedly use many more silver bearings than pre-war.

Aluminum and Magnesium Powders

With all the interest in powder metallurgy and its post-war possibilities as a method for fabricating machine parts, it is well to remember that the metal powders now in largest production are used for an entirely different purpose. The amount of aluminum and magnesium powder used in bombs and flares represents far and away the largest metal-powder application in the war; actually the annual tonnage production of aluminum powder alone (mostly for pyrotechnic use) may soon approach the corresponding prewar figure for aluminum metal in all forms. All of which suggests a tremendously expanded post-war use of aluminum paints and printing inks, thermit welding, aerated concrete, and other established peacetime applications of aluminum powder. But, we ask, who knows how we will use our great magnesium-powder production capacity when the war is over?

Steel in Housing

New uses for steel in post-war houses will include structural framing and covering, the steel being cold-formed to the desired shape from the original flat light sheet or strip under ⅛ in. thick. For single-family prefabricated dwellings structural members can be thinner than elsewhere; the light-gage steel is highly formable, and once erected, shrinks less than other materials, including plywood and seasoned lumber.

Marriages and Prosperity

According to one economist the only possible business outlook must be optimistic because 6.6 million couples have been married during 4 years of war, have had to postpone the usual housekeeping, and when they do settle down will give a great push to the already enormous pent-up demand for consumer goods. All of which is doubtless true but gad! how we wish that's all there was to it.

Airplane Production

Even with a possible 900% increase in passenger-mail-freight ton-miles flown inside our borders in 1950 as compared with 1940, the total number of commercial planes needed for such a projected load would be only 575, according to a recent statistical estimate by experts of one plane company. Planes will be much larger and faster than in 1940, thus tending to reduce their number. Of course foreign traffic may swell output but not to more than a total of 1800 to 2000 commercial planes. Military planes may therefore continue to represent the heavy bulk of new airplane production 5 years hence, even though we be at peace. But restrained predictions of this type were made in 1910 by the automotive industry, who predicted "saturation" at 7.5 million cars. The future that happily confounded this automotive prediction may do likewise for aircraft, with the "private-flying" potential the great unknown.

Induction Welding

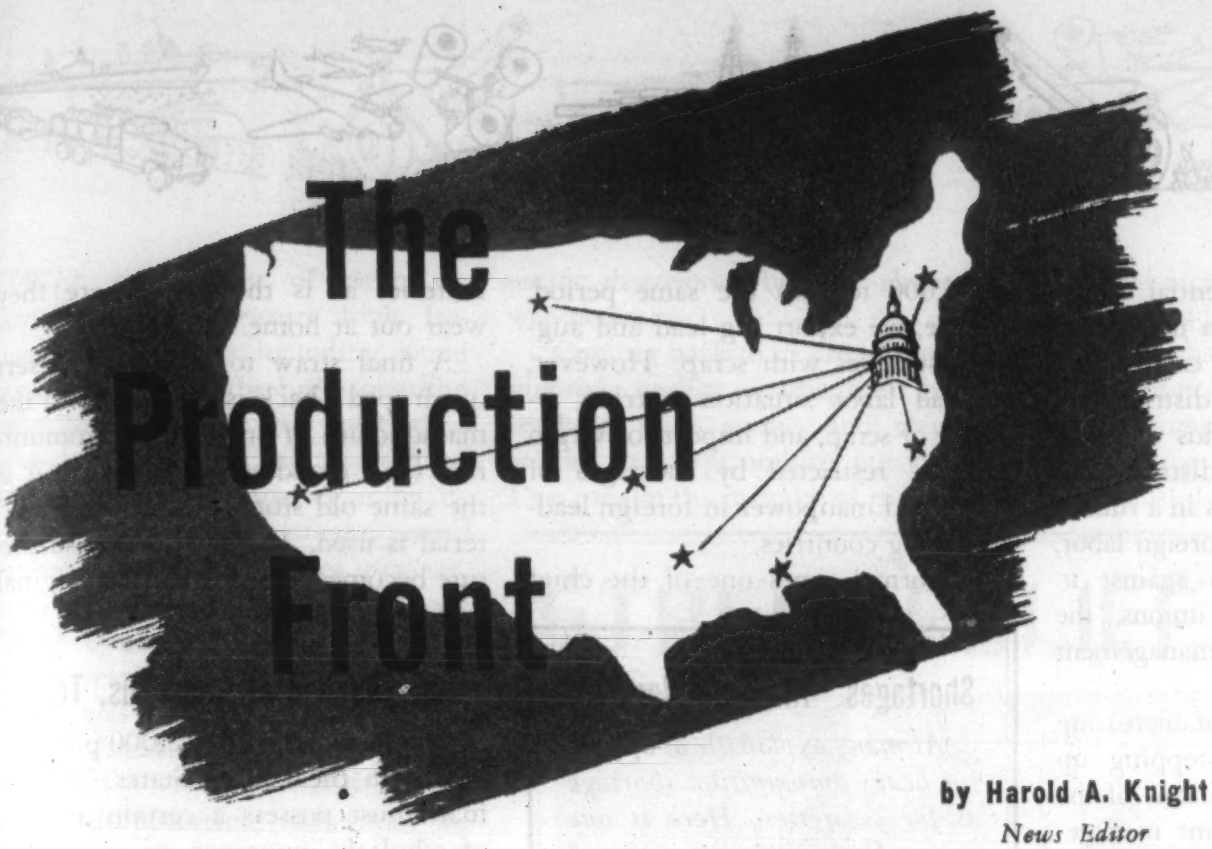
Watch for the invasion by induction heating of a new field of application—welding—and on a fairly large scale. One company has developed a method of induction butt-welding 24-inch pipe for oil-field and other pipeline use, with pressure and high-frequency heating simultaneously applied. We suppose it has its bugs, but so did resistance welding, years ago!

Gas Turbines

Gas turbines, light, compact, easy-to-maintain sources of motive power that they are, may remake post-war transportation. A large aircraft engine manufacturer predicts airplane speeds of 600 m.p.h. using gas turbines soon, with many-ton increases in passenger and freight tonnage also resulting. One of the largest electrical manufacturers has established a separate gas turbine division, and all predict their use for various purposes.

Solders

According to those who study these things, the post-war tonnage of solder used will not be greatly different from pre-war. An increase in total consumption is unlikely because some people have learned how to get along without solders. Although the low-tin solders have proved their utility, there will be a considerable return to high-tin solders once the tin becomes available again. There will probably be a small reduction in the average tin-content of solders. Cored wire solder has gained in popularity because of its convenience for mass-production use.



by Harold A. Knight
News Editor

Ammunition shortage came as shock. . . . We'd been patting ourselves on our back. . . . Yes, and we're short on cotton duck, combat loaders, Navy rockets, etc. . . . We are accelerating fastest on Navy rockets, B-29's, 40-mm. A.A. guns, airborne Navy ammunition, tenting and Army heavy artillery ammunition. We make Cherbourg a phenomenal port. . . . We adapt captured Nazi ammunition to our guns. . . . French and Low Countries make mortar shells for us. . . . Strange war! — look at copper and lead. . . . Back-seat driver explains shortage. . . . 'Gag' researches sometimes do the impossible. . . . Chemical Society lists 1500 war materials with peace implications. . . . Our cartoon salutes the welding industry.

We've condensed some facts about the jet airplane. . . . Its simplicity is evident throughout. . . . Textbooks that call industry "a big bad wolf." . . . An injection carburetor is as complete and precise as the engine itself. . . . We're writing "finis" to the sub-zero treatment nomenclature campaign.

Thoughts on Shortages, Recoveries and Improvisation

Surprises in our war production program have been as frequent and momentous as a melodrama of the "gay 90's." To think that this great nation of ours should be embarrassed over some dozen critical shortages of finished fighting goods—especially after so much patting of ourselves on the back!

But as Hiland G. Batcheller, chief of operations, WPB, puts it: "You can't plan a war like an automotive production program." Severe indeed is the shortage of cotton duck for tenting our G.I.'s. Apparently we first thought our soldiers would not stand still long enough to use a tent. There is a stupendous demand for repair parts—a demand not 100% anticipated.

On the manufacture of combat loaders we have missed the schedule badly. On Navy rockets we have set a superhuman program. Comforting, is that on mortar shells the program has been reduced—hence, our production program is not a one-way street.

Where We've Done the Most Crescendoing

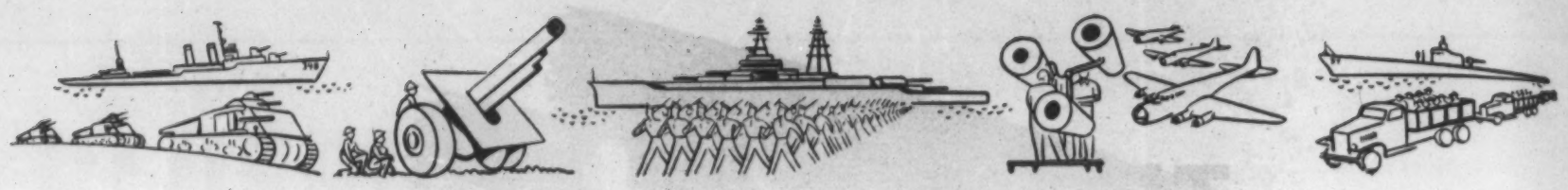
Our best production progress in recent weeks has been on Navy rockets, the Superfortresses, Navy 40-mm. A.A. guns, airborne Navy ammunition, cotton duck and ASF heavy artillery ammunition. At the Siegfried Line, ammunition and tires are the great needs. In late December there was a momentary shortage of trucks, to be relieved after better port facilities are established. Speaking of ports, Cherbourg, which never handled over 3,000 tons of cargo per *month,* is now siphoning through it 20,000 tons per *day.*

In speaking of shortages, a prominent general concerned with supply said to us recently: "I can remember the charges against us when we built up surpluses—charges of extravagance. As to the present situation, it would be tragic if our troops broke across the Rhine and merely sat there, waiting for more supplies to catch up with them."

Helping the situation are German munitions captured in France and the Low Countries. German 81-mm. mortar projectiles can easily be used in our 81-mm. weapons. American tank guns can use Nazi 75-mm. shells. German 105-mm. ammunition is slightly modified for our famed 105-mm. howitzer. Moreover, we have captured many German guns, which we quickly repaired, if necessary. We use some Russian guns, hauled by Nazis to France. Again, Belgium and French concerns are making 60- and 81-mm. mortars for us. One plant makes 100 mortars weekly.

Manpower Situation

A member of the War Manpower Commission talked to us recently on the necessity to fill 300,000 more war jobs in the next few months. It is a matter mostly of transferring and squeezing needed manpower out



of other and less essential work. Trouble is, there is much inelasticity in the situation. You can't move women from district to district.

There may be a surplus of labor in a rubber producing district—but you can't make munitions in a rubber plant. As to importing foreign labor, there are many reasons against it. Objections come from unions, the local community and management often balks.

One of the best ways of increasing production is through stepping up efficiencies and "presenteeism" of the current labor forces. Plant management constantly becomes more skilled in keeping absenteeism at a minimum. Proper supervision can keep it down to 1% per month. One effective morale builder is to keep a returned veteran in his uniform wandering through the plant—that has a magic effect.

Copper and Lead Turn 180 Deg.

The economics of the war have taken several somersaults, but none more interesting than copper and lead. Two years ago copper was the No. 1 critical metal, with lead by far the most abundant. By now the cycle has turned nearly 180 deg. Copper is so plentiful we are even exporting it freely—to England, Brazil and other South American countries, with permission granted by the Government to export to Spain, though a willing seller had not been found, according to last reports.

Copper authorities assure us that there is plenty of red metal for the duration of the war, irrespective of war's length. We saw a year ago how steel cartridge and shell cases were abandoned because of abundance of copper.

In lead there is talk of probable allocations by the Government before long—a metal which so far has been entirely free of restrictions. Stockpiles of Metals Reserve Corp., around 100,000 tons, are only about one-third those at the peak in the spring of 1943. Consumption of lead is running 90,000 tons per month as against a domestic mine production of 35,000 tons in the same period.

True, we export pig lead and augment supplies with scrap. However, the bad labor situation restricts recovery of scrap, and imports of virgin lead are restricted by shortages of power and manpower in foreign lead-producing countries.

In normal times one of the chief outlets are storage batteries for automotive vehicles. Most of our battery production is now being shipped abroad and there is no return of spent batteries as is the case where they wear out at home.

A final straw to break the desert quadruped's back is the return to the manufacture of small arms ammunition on a grand scale. After all, it is the same old story. A substitute material is used. But finally that substitute becomes scarcer than the original material.

Shortages: Armchair Version

As many explanations appear for heavy ammunition shortage as for cigarettes. Here is one more. Our militarists assumed "blitzkrieg" was the permanent new type of war, with sieges of cities and heavy gun firing obsolete. But, a blitzkrieg works only under two conditions: First, where the enemy is appallingly weaker, and second, where it is novel to the foe.

An example of the first was the German invasion of weak Poland; of the second, the Nazi invasion of powerful France. We worked the blitzkrieg successfully in Africa and Sicily, but always the Germans were definitely much weaker.

But along the Siegfried Line the Germans have been almost as strong numerically and in firepower—and, naturally, are not surprised by blitzkrieg. Hence, the war develops into an old-fashioned slugging match.

So, our militarists, too, were carried away by the razzle-dazzle of blitzkrieg and did not picture, as they should, the return to the heavy slugging of the first World War. Why, the Germans have even been back again in trenches as in War I.

This is perhaps the first real mistake our military has made. They're still tops over the Germans and Japs, though!

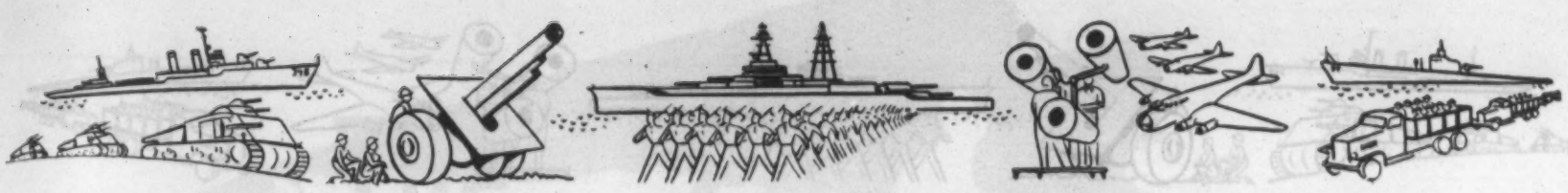
They Laughed at Columbus, Too!

There are probably 12,000 pure scientists in the United States. "Such a man must possess a certain amount of scholarly ignorance, or at least be ignorant enough to tackle the impossible. For example, the frosted bulb. The process of frosting electric light bulbs was discovered when a new apprentice in a big electrical company took seriously a 'gag' piece of research. The assignment was an 'impossible' one—a sort of hazing routine. He went to work and turned up a process that not only did the trick but added materially to the strength of the finished bulb."

So spoke Dr. Howard E. Fritz, director of research, B. F. Goodrich Co., to an industrial group recently.

"Dr. Waldo L. Semon was called to Washington to testify on synthetic rubber. A Cabinet officer asked him from what it is made. 'Coke, limestone and salt,' he replied. 'Waldo, you are a nut,' the Cabinet member volunteered. 'Yes, I guess so—But I understand that a nut is something to keep screws from getting loose,' the quick-witted doctor replied.

"Many years ago it was observed that bats flying around in a cave studded with stalactites and stalagmites always cleared the obstacles even if light was totally absent, but no evidence could be obtained pointing to a clue as to how they did it. Later it was surmised that a bat steered himself by the echoes from a sound which he emitted, for if we taped his eyes he flew just as well as ever. If his ears were taped, not so well, but pretty good. But if we taped his mouth he just sat. We never could prove it because we could not detect any sound.



"With the advent of radio we learned how to measure high frequency disturbances, including sound waves, and gave it the high sounding name 'supersonics.' We were then amazed to find that bats did emit a sound and guided themselves by its echo. The frequency of the sound emitted was 90,000 cycles per sec. Human ears can detect nothing above 20,000 cycles per sec. It took us 10,000 years to learn that which to the bat was simple instinct.

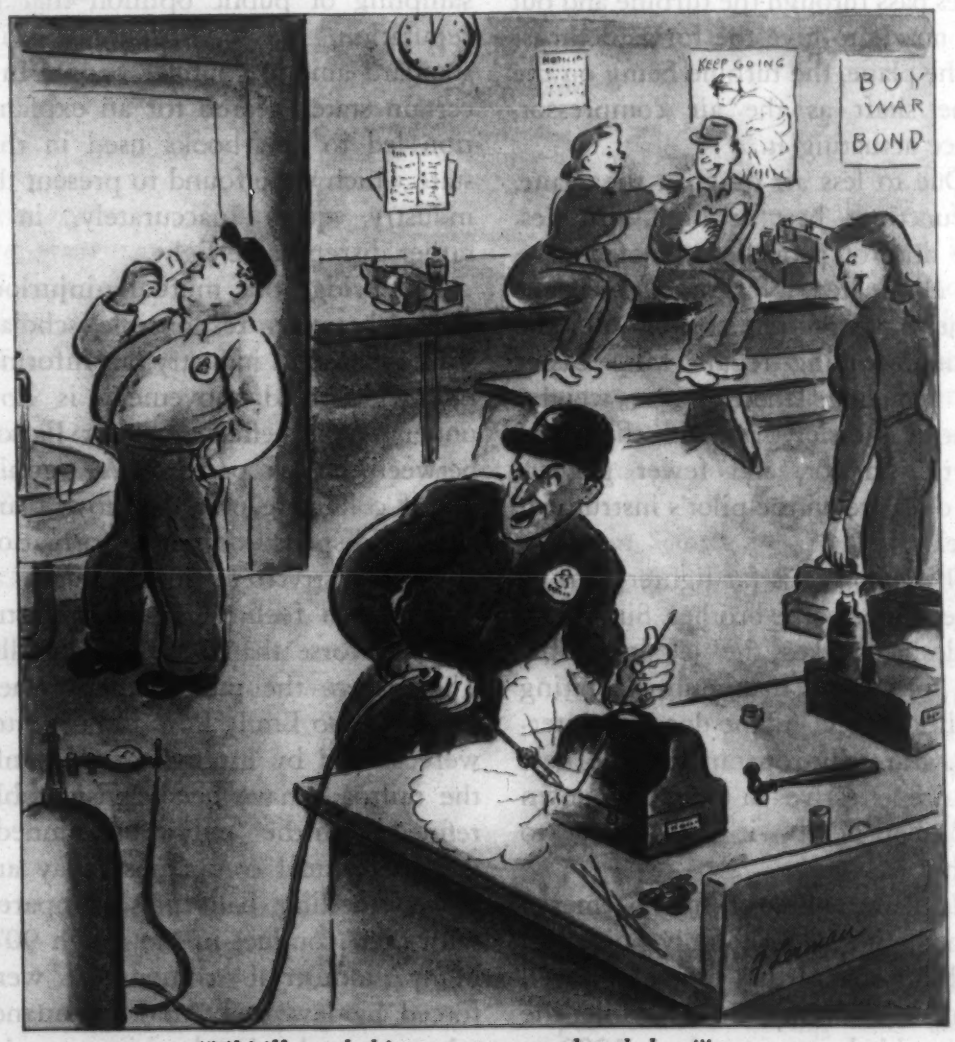
"The American Chemical Society alone lists 1500 new war materials for which peacetime uses must be found. Here are some: A chemical which provides an invisible raincoat for anything dipped in it, though microscopes reveal no film upon the substance so treated; a germ-killing chemical, DDT, so toxic to insects that one treatment of a space is effective for 60 days (Dichlorodiphenyltrichlorethane); transmuted wood, by simple impregnation; true fruit juices by the action of bacteria on plain sugar; a powerful germicide, Tyrothricin, produced by microbes in the very soil on which you walk, an unparalleled weapon against chest infection, boils, carbuncles, ulcers, etc., with high hopes for quick cures of sinus infections; a new family of plastics, the silicones, heat-resistant up to 500 F., good electrical insulators, and in the form of oil, lubricants of great value as low as −50 F., all made from sand; synthetic quinine, not a substitute, the 'real McCoy' and a scientific triumph; vitamins from common weeds; hyoscine, (scopolamine) a chemical drug for the prevention of sea and air sickness; aluminum in fantastic volume and made from the very mud at your feet; triptane, trimethyl butane, 150 octane motor fuel, a designed molecule; new rubbers by the hundreds, made from wheat, corn, garbage, soybean, coal, petroleum, limestone, milk, sweet potatoes and salt; glass fibers and threads with tensile strengths of 3,500,000 p.s.i., ten times that of mild steel.

"Scientists estimate it will take about 20 to 25 years to bring to full commercial maturity most of the scientific discoveries brought about by war necessity.

"Coming back to us are millions of vigorous healthy youths, their brains seething with genius and courage, trained to accept nothing but victory. Don't make the mistake of the ardent father who refused his son the use of the old family jallopy because of his immaturity only to have the lad come home a year later at the controls of a $250,000 bomber!

"Our entire war production in one year, translated into automobile production, would provide every person now owning two cars with 56 autos. What a parking headache that would be!"

STRESS RELIEF By GILBERT



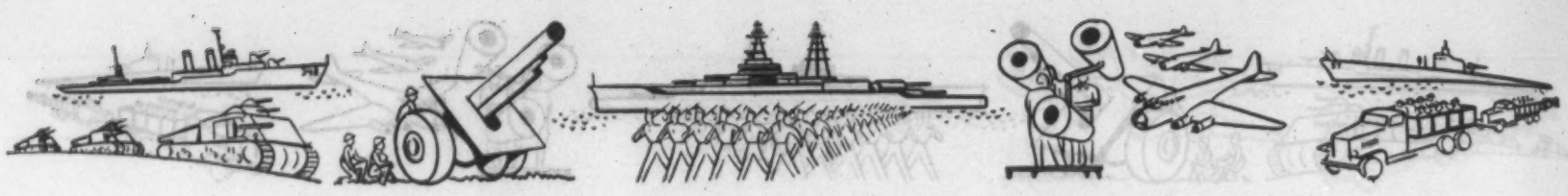
"This'll teach him to open my lunch box!"

Simple Jet, Simply Described

Here are some little known facts about the (by now) well known jet propelled airplane, gleaned from details released by General Electric. The wonder is that it was not developed before, for it is infinitely more simple than the complex, temperamental gasoline engine. Trouble is, our forefathers just didn't know how to make the engine—and, more important, they didn't have the alloys to stand up under a constant 1200 F.

It will burn kerosene, gasoline or Napoleon brandy, according to whimsical Captain Ezra Kotcher, Fighter Branch, Engineering Div., Materiel Command. Hioctane gas definitely is not a mandatory fuel. Kerosene has less tendency to ignite in the open air than gasoline. Chief drawback is that the jet consumes more fuel than the reciprocating motor.

As models are improved speed approaches the 764 miles per hr. of



sound. Thirty seconds after it starts operating the jet generates enough power for swift run along the air field. There is virtually no vibration.

The jet plane is started by a small electric motor that shuts off when enough speed is generated. Blades suck in air and compress it in the compressor, whence it is fed to the combustion chamber where fuel is burning. The powerfully expanded gases pass through the turbine and out the nozzle to give the forward thrust to the plane, the turbine being on the same shaft as the air compressor, hence actuating it.

Due to less air drag on the plane, it functions best at high altitudes. The drag of propellers is, of course, also eliminated. No propellers means plane construction lower to the ground, making repair work easier and reducing landing gear weight. Control is easier than with the reciprocating motor, and fewer gadgets and dials are on the pilot's instrument panel.

The jet plane is far lighter than its more cumbersome brother. Simplicity of design makes the jet incredibly easy to keep in maximum operating condition. The engine does not interfere with radio operation. The new jets are effective in bringing down the robot bomb—it takes a jet to catch a jet.

No flame, glow or smoke emerge from the nozzle. The only noise is a rumbling roar. It has functioned well with air at minus 76 F. while the turbine blades were at least 1200 to 1500 F. Experience in manufacture was gained from the supercharger. Companies other than General Electric are making the jet engines, including Allison Div., General Motors.

They'll have to revise the old song to: "Come Josephine in my new jet machine—"

Certain Textbooks Innuendo Industry

"This war was started by Wall Street—let them fight it and finish it." That astounding statement was made to us by a technical sergeant about to go overseas to repair tanks and other automotive equipment in Europe. We just grunted—we could see it was no use arguing with him.

Then recently we received under auspices of the National Conference of Business Paper Editors a piece from J. G. Lyne of *Railway Age,* entitled: "A Neglected Area of Public Relations." We quote:

"Not long since, a large industry discovered by means of a scientific sampling of public opinion that its reputation was surprisingly substandard among younger people in a certain state. Search for an explanation led to text books used in that state which were found to present the industry, quite inaccurately, in a rather disreputable light.

"To bridge this mutually-injurious chasm between responsible scholarship and useful industry, an informal but widespread movement is now under way to effect a closer liaison between the two parties." A committee of collegiate men are now available to dispense correct information about industry to all interested.

Our own feeling is that industry was no worse than society generally. Those were the pioneer days when there was no Emily Post and disputes were settled by fist fights. Certainly the railroads have been considerably refined from the "public be damned" days. Big steel companies today are sweet smelling ballerinas compared with their conduct in the rough 90's. Many industrial companies were forced by law to be more humane; others saw the handwriting on the wall and reformed themselves. Through the years the wisest have realized in a hard-headed sort of way that what is good for the employees is good for quality and quantity of product.

But, to get back to the text books. Authors, may we suggest that you pull out all the stops in portraying the seamy side of industry—but, with equal emphasis, paint industry, too, as it is today: human and humane.

Injection Carburetors

Inasmuch as predictions have been made that the post-war automobile will contain an "injection carburetor," the following sketch from Bendix Aviation Corp., relative to these carburetors made for airplanes in Bendix plants, is timely.

These carburetors represent 15 years of continuous research. A typical unit may contain 500 individual parts of extremely fine tolerances. Production is comparable to building a complete, highly precise automobile engine.

These carburetors automatically and accurately deliver to engine superchargers a fine, evenly atomized mixture of fuel and air at all engine speeds, independent of changes in altitude, propeller pitch or throttle position. They have aided tactical aircraft to fly higher, carry bigger pay loads and enlarge cruising radii.

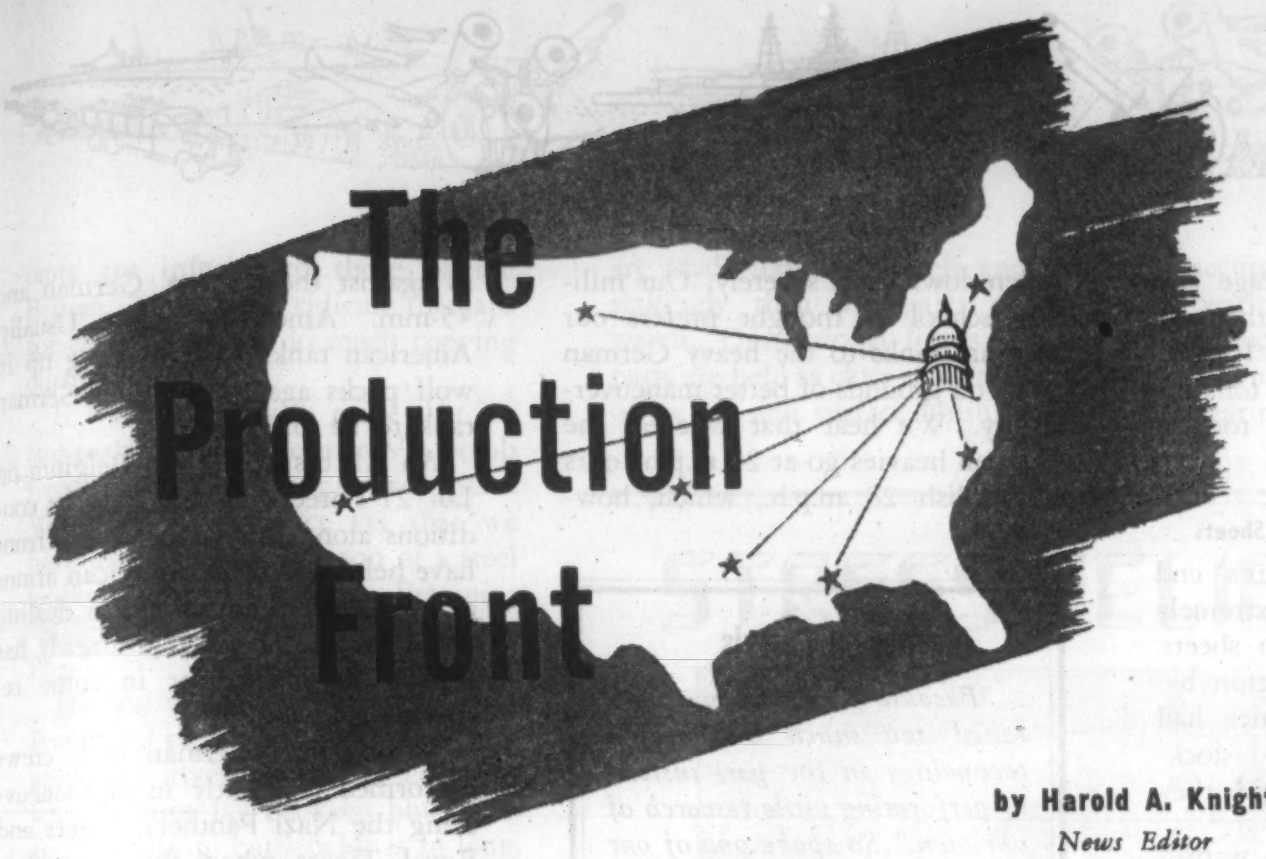
The improved fuel-metering devices now equip 90% of American and United Nations warplanes.

"Chauffage" and "Refroidissement"

In finding a popular nomenclature for sub-zero treatment of metals, J. G. Henderson, mechanical engineer, Charleston, W. Va., would turn to the French—appropriate in view of the comeback of France as a nation. He would use "chauffage" for heating and "refroidissement" for cooling. Of course, from a strictly scientific standpoint everything is hot this side of absolute zero.

However, we've got to draw a line—let's draw it at 62 F., which represents atmospheric or normal temperature. Again, "thermal" treatment is more accurate than "heat" treatment.

So—"Tr 150 F." is "thermal refroidissement 150" or 150 deg. below zero. "Tc 1950 F." is "thermal chauffage 1950" or 1950 deg. above zero. And as we write this we are Tc 100 F. with nervousness because one in authority in our office hinted that we've published enough on this subject—and we don't know how he'll take this further exposition. But we do believe Mr. Henderson should have his say. He has an idea that has much to commend it.



by Harold A. Knight
News Editor

Krug says we'll have severe materials shortages again. . . . Civilian use of lead curtailed for first time. . . . Tin can salvage must continue after Japan is beaten. . . . Cadmium is one of most critical metals. . . . Worry about iron ore stocks. . . . In galvanizing circles steel is more serious than zinc. . . . Mine production of metals slumped in 1944. . . . Washington misjudged aluminum sheets.

Our faces should be red concerning efficiency characteristics of several of our pieces of war equipment. . . . Our tanks are decidedly in second or third place. . . . "Pot calls kettle black" when we kid Japs for copying. . . . Our tank and anti-tank guns don't win blue ribbons. . . . German infantryman is better equipped than ours. . . . "Make armor plate thicker, Pop," son writes back to steelmaker father.

Cartels mostly stifle business and inventiveness. . . . Even hard-crusted we honor Valentine's Day via a cartoon. . . . They make anti-friction bearings more precisely than a Tiffany watch. . . . In the new windowless factory they post outside weather conditions hourly. . . . Tankdozer is a clever 2-in-1. . . . Plastics and steel compared pricewise. . . . Whimsical items from the news.

Basic Materials Shortages With Us Again

Keen shortages of basic materials will again feature war production in 1945, J. A. Krug, head of WPB, stated recently. As to shortages and bottlenecks, they have moved like a merry-go-round.

Early in our war efforts, raw materials shortages rated No. 1 problem. Then it passed along to components, labor shortage and finished war goods. But, with the stepped up war effort, the cycle seems to be starting all over again.

One key to critical shortages lies among the nine Government drives to collect scrap materials—those in waste paper, tin, used fats, iron and steel scrap, aluminum, hosiery, rubber, old clothing and rags. Only two, tin and waste paper, must be driven for on an intensified basis and the need will not slacken until well after victory in Europe. In the other seven items, collection has slackened or perhaps ceased.

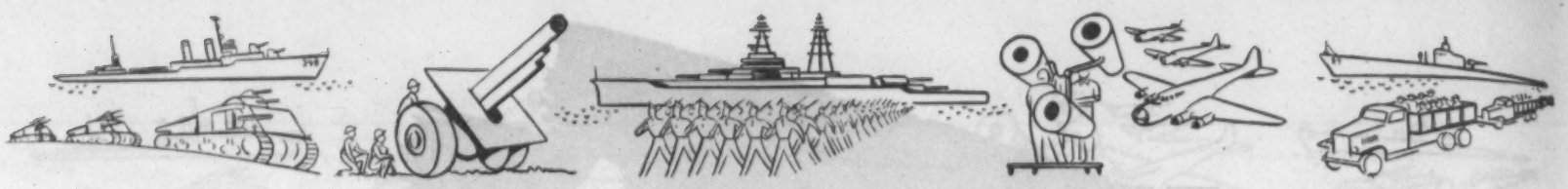
Household preparation of tin food cans may be necessary for a long time even after the Japs are beaten, says WPB. Recovery from cans is more imperative than ever because all other recoverable forms are about exhausted. Demand for tin in shipbuilding now exceeds all previous estimates.

Biggest Surprise Has Been Lead

Lead, until six months ago the most plentiful metal, rapidly becomes very critical. For the first time WPB has started to limit its consumption. Civilian uses of lead have been restricted to 60% of the 1944 level. The Government estimates 1945 lead requirements of 1,150,000 tons against total supplies of 970,000 tons.

Government reserves are under one month's consumption, having been decreasing 15,000 to 25,000 tons per month during the last five months. Labor shortages are chiefly responsible, and what might supposedly be secondary sources are lacking because so much lead is shipped out of the country in the form of batteries, ammunition, etc.

Cadmium may well be called the scarcest metal now, with estimated requirements for 1945, chiefly for plating, 5% over 1944 needs. Overall stocks have fallen 25% in a year. Uses are heavy in cadmium plating for aircraft and tanks, not to mention the stepped-up rocket program. Recoveries from scrap are poor from difficulty of eliminating impurities.



A possible iron ore shortage is a warning from WPB, stating that mill stockpiles on April 1 will be 16,000,000 tons against 21,000,000 tons the year before and 34,000,000 tons at the record in 1942.

Washington Erred on Aluminum Sheets

Miscalculations as to war's end date have resulted in an extremely tight situation in aluminum sheets. A few months ago Washington believed that aircraft companies had tremendously overbought and stockpiled. Now, it is discovered they were actually conservative.

T. E. Covel, deputy director, WPB's Aluminum and Magnesium Div., stated recently: "Unless manpower is immediately obtained, the national demand for aluminum sheet in 1945 will present the most serious aluminum production crisis of the whole war."

The undertone of steel shortages has been felt throughout the war. It crops up in many interesting ways. Thus, certain shortages of galvanized products might seem to be due to lack of zinc—but rather it is due to the more common and usually cheaper steel.

Metallic mineral production in 1944 reached $2,377,000,000, a drop of nearly 5%, according to Harold L. Ickes, Secretary of the Interior. Significant declines were in aluminum, bauxite, chromite, copper, ferro-alloys, gold, iron ore, lead, mercury, molybdenum, silver, tantalite-columbite, tungsten, vanadium and zinc. Gains were in beryllium, cadmium, manganese ore, pig iron, nickel and platinum.

Several of the declines were voluntary and due to an apparent surplus, at least when based on optimistic dates for the war's end.

Let's Not Swell Too Much With Pride

Often we Americans bloat up with pride over our production accomplishments. In large measure the bloating, encouraged by our brass hats, is justified. Yet, to reduce the swelling somewhat, we should consider our shortcomings.

Perhaps in military tanks we have fallen down most severely. Our military school of thought prefers our medium tanks to the heavy German tanks on grounds of better maneuverability. We hear that whereas the German heavies go at 20 m.p.h., ours accomplish 28 m.p.h., which, however, is not fast enough to compensate for poor armor.

Nix on Cartels

"Because of cartels we have relied too much on foreign technology in the past instead of performing virile research of our own." So spoke one of our foremost Washington experts on cartels to us, with the understanding that he not be quoted by name.

"An inconsistency of cartels in the U. S. is that at the time our Government is doing everything possible to stimulate trade, cartels are bringing pressure to limit or stifle trade. Masses in a large part of the world are against cartels, and most of them would like to see the U. S. take the leadership against them.

"Even suppose that all Europe goes back to cartels. That will not debar us. Actually, other countries need our trade more than we need theirs. Suppose Britain and other great countries cartelize and try for advantages over us. We can play the same game with tariffs and other trade discriminations. We are in a position of tremendous influence to fight the cartel idea. Even in England there is growing sentiment against cartels, particularly from the viewpoint of consumers."

The Russians have out-heavied the German heavies, to which is due in large measure their success on the Eastern front. This new "Joseph Stalin" tank carries a 122-mm. gun as against the 88-mm. German and 75-mm. American gun. Usually, American tanks have to gang up in wolf packs against a single German tank to be effective.

An AP dispatch from Belgium on Jan. 21 stated: "Severe weather conditions along this sector of the front have helped to place American armor at a distinct disadvantage in dealing with German armor that already has proved itself superior in some respects.

"While our Sherman tank crews performed brilliantly in outmaneuvering the Nazi Panthers, Tigers and Royal Tigers when the going was good, they are now finding it impossible to get off the roads to maneuver.

"This is where German superiority in firing power and defensive armoring has shown up in all categories—medium and light tanks as well as tank destroyers.

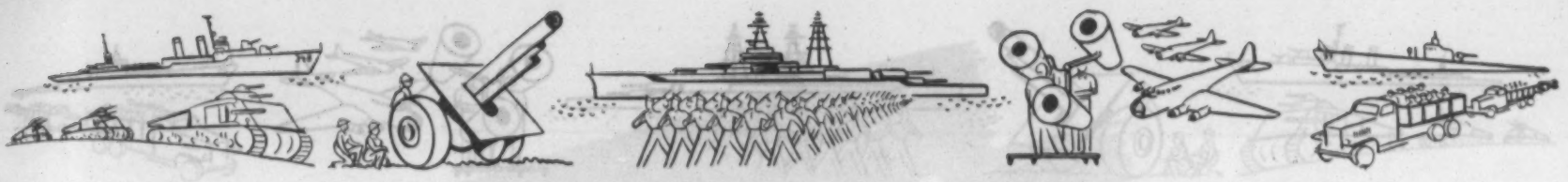
"An example of this superiority was demonstrated before Houffalize, when two American tanks were sent up to the brow of a hill to get off a couple of quick shots at a Panther and then retire. The Germans got off seven shots while the Americans got in two."

Too Much on Drawing Boards Only

Our 76-mm. high velocity gun and 105-mm. can punch through German armor, but only at close range. Both are outclassed for tank and anti-tank use by the new German 88-mm., writes Hanson W. Baldwin in the *N. Y. Times*.

The Germans have had jet planes in the air since June. Ours are either on the drawing boards, in pilot plants, or on our own flying fields—at least not on the fighting fronts. Our V-1 and V-2, etc. bombs may number in the tens of thousands, but they are not where the fighting goes on. In our winter campaign, our G.I.'s often had to improvise snow camouflage with sheets, lace curtains, etc., taken out of houses in occupied territory.

The German infantry soldier is better equipped than ours as to boots, raincoats and completeness of comfort and medical equipment. Our



tents are inferior to those of the British. Though we ridicule the Japs for copying us, we do much copying ourselves.

It was told us with pride that we had reassembled a German V-1 bomb from original and improvised parts. We have no evidence yet that we have a better V-1. The son of a steel worker wrote back from Belgium: "Make your steel armor plates thicker, Pop."

Hanson W. Baldwin blames Armed Forces red tape, and advocates a Congressional investigation to determine why the time lag between blueprints and delivery to battlefields is so long. Of course, Baldwin is conservative to the point of pessimism. On Jan. 16 he wrote: "The Russians should be in control of Warsaw by the spring thaws." Actually they were there on Jan. 17.

But we need our Baldwins lest we become too smug.

Fruit and Anti-Friction Bearings

"Don't Eat Fruit Here."

We saw that sign repeatedly when taking a 3-hr. tour through the Gwynedd plant of SKF Industries, Inc., a 45-min. bus ride from the N. Philadelphia station of the Pennsylvania Railroad. Finally we asked the why of that sign. "A squirt from a grapefruit would corrode these sensitive bearings—those that are still dry and not protected by oil film," we were told.

This anti-friction bearing plant is a model of modernity. There are no windows—to aid rust and dust prevention. In some departments Precipitrons attract out of the air all dust particles; temperature is kept at 75 and humidity at 40; floors are kept waxed in a way reminiscent of a Fibber McGee program; women wear non-lint producing dresses. Reports of weather outside are posted hourly to satisfy the curiosity of workers in this windowless factory.

The plant was built in a cornfield, miles from anywhere. But already this 2-yr.-old plant is obsolete from the standpoint of the next war, for it should be underground.

Bearings for turbo-superchargers are made more accurately and painstakingly than are parts of $100 watch. Dimensional limits of some parts are held as close as 25 millionths of an in., and surface finish as close as 3 millionths of an in.—and on a production basis of thousands of bearings.

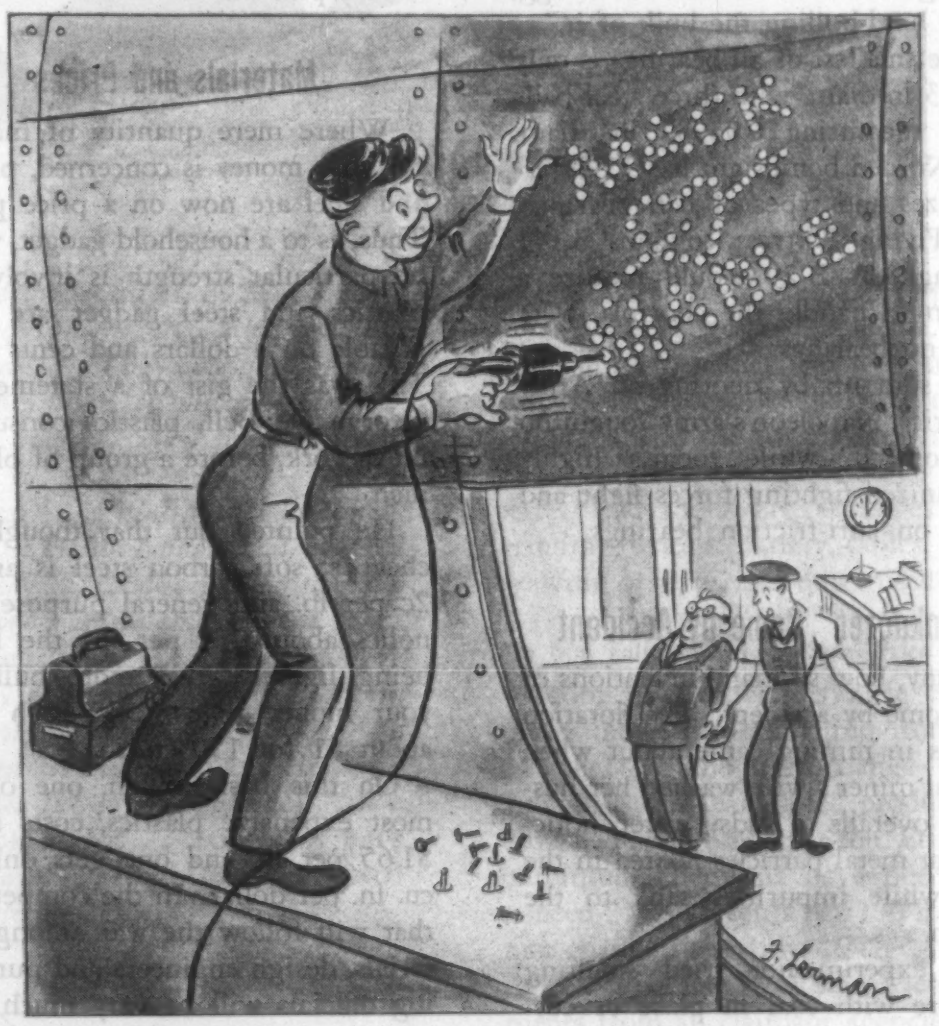
Products of this plant are preponderantly for aircraft. Rings, balls and rollers are of high carbon chromium steel of exacting analysis; retainers are of pressed steel, aluminum and bronze.

We also spent 3 hr. in the plant of Hyatt Bearings Div., General Motors Corp., Harrison, N. J., the oldest manufacturer of roller bearings. We were told that few realize that the accuracy required of anti-friction bearings is of a degree seldom attained in ordinary toolmaking.

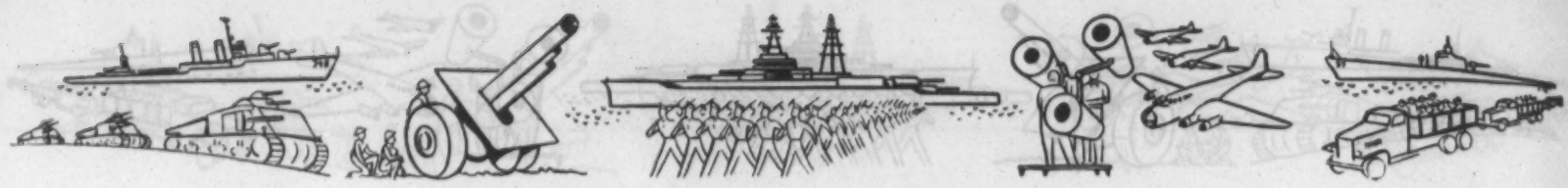
Unlike toolmaking, however, these bearings are mass produced by semi-skilled help, possible because of accurate gaging methods in the hands of constantly vigilant inspectors. Often two inspectors work with three productive workers.

For aircraft engine turbo-superchargers Hyatt builds roller bearings that run at 30,000 r.p.m. at 325 to 350 F. By heat treatment, the steel is stabilized so that it keeps its original dimensions. Bearings made by Hyatt, used in catapults that launch airplanes from the decks of ships, must sustain loads of nearly 1,000,000 lb.

STRESS RELIEF By GILBERT



"We can't say anything to him—he's on his lunch hour."



A special problem was making the steel collar for a bearing for the Oerlikon anti-aircraft gun. It must be soft at the ends so that it would bend to hold the roller retaining rings, but hard on operating surfaces. In solving it, Hyatt made an important new contribution to induction heat treat techniques. As a Hyatt man explained it: "We have done similar to soft boiling one small section of an egg, while hard-boiling the bulk of it."

The smallest of all bearings is only 0.1063 in diam. with three steel balls in it, measuring 0.03937 in. diam. The Norden bombsight has 35 different sizes and types of ball bearings. The Flying Fortress contains 3,141 bearings. A B-29 would require a Tarzan to handle the controls, were there no bearings.

To sum up by quoting an Army authority, Napoleon's army fought on its stomach, while today's highly mechanized fighting forces fight and travel on anti-friction bearings.

"Tankdozer" Came by Accident

Funny, how so many inventions of man come by accident. The flotation process in mining came about when a metal miner's wife washed her husband's overalls in sudsy water, noticing that metal particles floated in the suds, while impurities sank to the bottom.

An experimenter tried smelting iron ore with coal in place of customary charcoal. He gave up in disgust, slammed the furnace door shut and went home to lunch. Amazed was he, upon returning, to find perfect combustion and smelting. His successful pioneering eventually led to smelting with coke.

More recently on one of the South Pacific islands a "Seebee," riding a bulldozer, charged a Jap pillbox with his blade raised for protection, then scooped up earth and smothered the pill box. That improvisation on the spur of the moment sired the new "tankdozer," our new secret weapon. Here a huge bulldozer blade is mounted on an M4 General Sherman tank and combines some of the best features of both machines—the terrific work power of the bulldozer plus striking and protective ability of the tank. The blade is no mere razor blade, weighing 3½ tons.

The tankdozer is, of course, not used in ordinary construction work, but rather where construction is under enemy guns and where it is necessary to break roadways and perhaps in impromptu manner smother an enemy pillbox.

Materials and Prices

Where mere quantity of material for your money is concerned, plastics and steel are now on a price parity. Thus, as to a household gadget, where no particular strength is involved, a plastics and steel gadget are comparable on a dollars and cents basis. This was the gist of a statement of George De Bell, plastics consultant, New York, before a group of plastics men.

He pointed out that though the cheapest soft carbon steel is around 2c per lb. and general purpose phenolics about 13c per lb., the latter, being lighter, gives more bulk for your money than steel. Each costs about $1 for 150 cu. in.

On this basis, nylon, one of the most expensive plastics, costs about $1.65 per lb. and one gets only 15 cu. in. per dollar. In the competition that will follow the war among materials, design engineers and purchasing officials will be very much concerned with thousands of comparisons similar to these.

Doubtless values will be fluctuating constantly, and a price setup for one month will be out of date six months hence. Have your slide rules and tables handy, boys!

Off the Beaten News Path

Vital steel tubing was needed at the Bridgeport, Conn. plant of G.E. to keep bazooka manufacture on schedule. It was loaded in a midwestern city on a truck driven by Roy (Curley) Johnson, veteran of 13 yr. of driving trucks over the Alleghenies. On this trip with tubing he hit his worst snowstorm over the mountains. It took 24 hr. to drive the first 67 miles. He pushed ahead past stalled cars, with snowdrifts constantly growing. At W. Springfield, Pa., drifts were so high that snow was going over the truck's cab.

Stalled at last, he battled on foot four miles to a phone. He called his home office; they called Washington, who in turn called the Philadelphia Ordnance district, who in turn contacted the Pennsylvania state police.

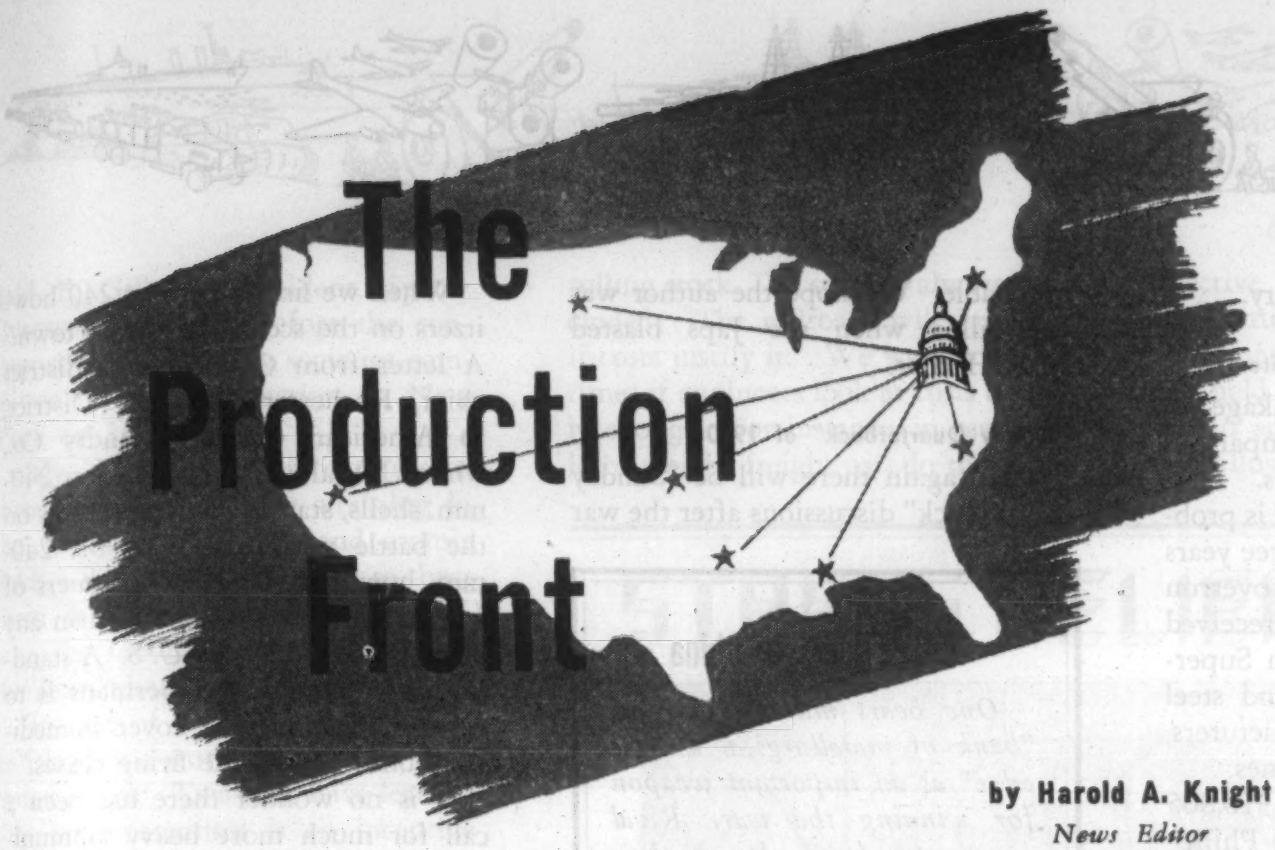
A relief convoy was formed in a matter of minutes. This consisted of a snowplow, truckload of cinders and a patrol car. They found an endless line of trucks ahead of the tubing truck, in some places two or three abreast. With the snowplow in the lead, they blasted a new road around drifts and stalled cars.

When Johnson's truck pulled into Bridgeport, he closed his eyes for the first time in four days and nights. Twenty minutes after his arrival the steel tubing was being fabricated into bazookas. Wonder if each bazooka will have a stormy career?

When the bill collector of a large store tried to collect the $195 debt from the owner of a so-called worthless tin mine, the penniless owner, in desperation, turned over the mine to him in lieu of payment, states *Coronet* magazine. The store officials fired the debt collector for this supposedly piece of bad business. They threw the certificate of mine ownership out the door along with the bill collector. He pocketed the certificate and an aged uncle paid the $195 to save the family honor.

The uncle advanced $300 more for working the mine. Along with his wife and two laborers they started hauling ore and rock out of the mine, living like hermits in the mountains. With his meagre profits the owner bought additional and adjacent land. Five years later the mine owner sold 49% of the mine to a large New York bank for $50,000,000.

This bill collector was Simon Patino, tin king of South America, whose tin is helping keep the wolf from the door in the Allied effort in this war.



by Harold A. Knight
News Editor

Graph illustrating shortages, a rising one. . . . Steel operations, 89.3%, lowest since July, 1942. . . . Winter, rather than worn equipment. . . . Zinc will be allocated again. . . . Tin can salvage to be nation-wide. . . . They change the rules on lead allocations. . . . Prices of pig iron and chromium chemicals rise. . . . We're short 3,000,000 tons of steel for second quarter. . . . France given 100,000 tons of steel.

Germany and Japan really know steel shortages. . . . Philippines supplied Japs with iron ore, manganese and chromium. . . . History book material on ordnance and military strategy now being formulated. . . . Lindbergh had warned on Germany's underground plants. . . . But one pre-war statement went sour: that Hawaii was impregnable. . . . Russians don't count on rabbits out of hats. . . . When our 240's fire, the Krauts don't try to fight. . . . West Pointers of 1950 will discuss 1945 tanks, guns and air bombing.

"Germans would have won if they had waited and accumulated." . . . Housefly has better gyroscopes than we. . . . Let employees see the product grow. . . . We study captured equipment. . . . Japs don't stint on alloys. . . . Germans have improvised and changed their metallurgical formulas. . . . Army Ordnance bursts into song. . . . China needs up-to-date technical articles.

Steel and Metal Shortages Are Intensified

That old bugaboo, shortages, has been hovering like a vulture over our war production again. Steel ingot production at mid-February fell to 89.3% of capacity, the lowest in percentage since July, 1942. A severe winter blocked roads and kept workers from steel plants and hindered arrival of fuel and other raw materials at plants. Not only are steel output and supply at the mills cut, but many consumers of steel have let inventories sag to low levels on belief that the European war would end in 1944.

Zinc will shortly join the lengthening list of metals that will again be placed under allocation, having gone off allocation on Sept. 15, 1944. Indicated 1945 consumption of zinc is 1,078,000 tons, compared with indicated production, including imports, of 870,000 tons.

Greater need for tin is indicated by the new WPB order requiring household processing of used tin cans throughout the United States, whereas previously it had been confined to cities of at least 25,000 population in 33 designated states.

Manufacturers and distributors of specified non-essential products containing lead were prohibited from further sales, as of Feb. 28, typical items being badges and emblems, costume jewelry, games and toys, statuary and art goods. At the same time, a more liberal use for civilians is allowed in the form of storage batteries, lead for X-ray, abrasives and grinding wheels, battery cables, cold drawing of wire, and other uses.

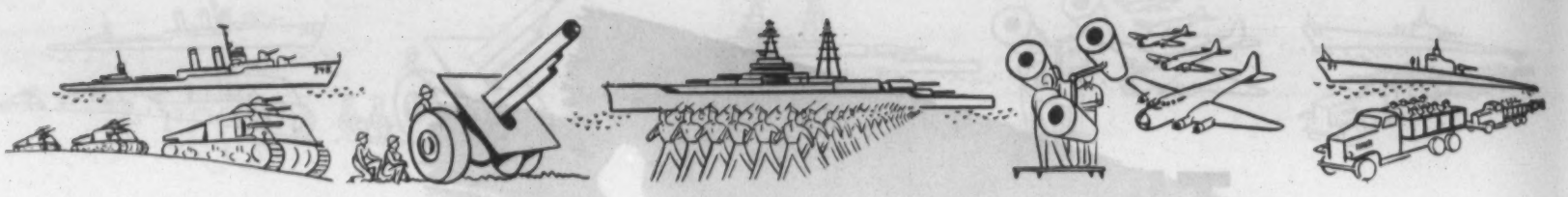
Pig Iron Follows Previous Steel Price Rises

More price advances have taken place, the leader being pig iron, up $1 per ton, the first change since July 1941. Meanwhile, production costs had risen $4.79 per ton. Primary chromium chemicals have been advanced 25 to 75 cents per 100 lb., the first change since July, 1941.

To get back to steel, stated requirements from all claimant agencies for the second quarter are about 3,000,000 tons in excess of estimated supply. Hence, all claimants will suffer very substantial reductions, including the military. Mere civilian needs may not be allotted a pound, while essential civilian requirements, such as railroads and farm machinery, may be cut severely.

France has been granted 100,000 tons of steel for first quarter for rehabilitation, which is necessary if the French are to give active help in fighting the Germans.

It is interesting to note that steel production cuts were not due to breakdown of machinery, as would be expected after so many months of 100% operation, but rather because of the severest winter in 25 years in



several sections of the country.

Look at Germany and Japan re Steel

However, our own shrinkage in steel supply is nothing in comparison with losses by our enemies. Germany's steel making potential is probably only one-third that of three years ago when the Nazis had overrun most of Europe. Japan has received serious blows, not only from Superfortress bombings of iron and steel plants and steel-using manufacturers, but from loss of the Philippines.

In 1940 Japan obtained 1,310,805 net tons of iron ore from the Philippines; in seven months of 1941, 954,300 tons. In 1940 Japan received 50,000 tons of manganese ore and probably impressive tonnages of chrome ore.

Lindbergh Warned of Underground Plants

What munitions we produce today, what we fail to produce and how we use our weapons will be the subject of discussions for many years to come. The Russians are inclined to belittle the effects of our strategic bombings. Only recently they captured a tremendous German plant underground in Silesia, 100% in working order. Which reminds us of an article written by Charles Lindbergh several years before this war started and following his tour of Germany and Russia.

Lindbergh commented on the hundreds of German plants even then underground, complete in every detail, with hospitals, dining rooms and even with sharpened pencils on every desk, though the plants were not then operating. Since then the Germans have doubtlessly built hundreds more underground plants.

We haven't heard much about Russians bombing since their war with Finland. Their wonderful success on the Eastern front seems to be due to the old fashioned football technique of mass play rather than razzle dazzle hipper dipper plays. Does this set the pattern for future wars?

Speaking of articles before the war, we recall one in *Collier's* around 1938, in which it was claimed that Hawaii and Pearl Harbor were impregnable. We hope the author was not killed when the Japs blasted Pearl Harbor.

"Sunday Quarterback" of 1950

Then again there will be "Sunday quarterback" discussions after the war on why we did not use more heavy tanks and guns. During the invasion of Italy it was a long time before any gun larger than the "Long Tom" arrived. For many weeks German guns outranged ours.

When we finally get our 240 howitzers on the scene, we "go to town." A letter from Col. Atwood, district chief, Rochester Ordnance District, to American Car & Foundry Co., whose Buffalo plant is making 240-mm. shells, states: "Official reports on the battle performance of the 240-mm. howitzer state that prisoners of war fear this weapon more than any other produced by the U. S. A standing order among the Germans is to cease firing and take cover immediately until the hostile firing ceases."

It is no wonder there has been a call for much more heavy ammunition and big guns, and it is too bad we allowed shortages to develop. The Russians have achieved their success with big guns and big tanks and old style football tactics. Of course, we have been limited by need for amphibious landings, which necessitates only lighter material at first.

Today To Be Textbook for West Point

So, about five years from now we can picture somewhat this conversation around the fireplaces in the lounging halls at West Point:

"You say strategic bombings are a failure because plants go underground. Yes, but how are you, who favor big-time ground operations, going to get your 240 howitzers through the snow, muddy roads, flooded streams? You say again that the super heavy tanks, like the Germans' of 1945, are far superior to the medium tanks like the American Sherman. Well, they are if you always have paved straight roads for operations. But tank battles are fought in the fields where a fast-moving tank can run circles around a 'Tiger' or 'Panther'."

Yes, they'll still fight the battles of production, strategy and tactics. But you and I, reader, will be discussing whether plastic or metal egg beaters are superior.

"Know How" to China

One hears much about our "bank of metallurgical knowledge" as an important weapon for winning the war. Rival companies have shared their "know how" and trade secrets with abandon, as is called for in a war for survival.

But consider the Chinese. They have virtually no technical literature of a date later than 1938, according to the American Iron and Steel Institute, a plight discovered by H. W. Graham, Jones & Laughlin Steel Corp., who accompanied Donald M. Nelson to China.

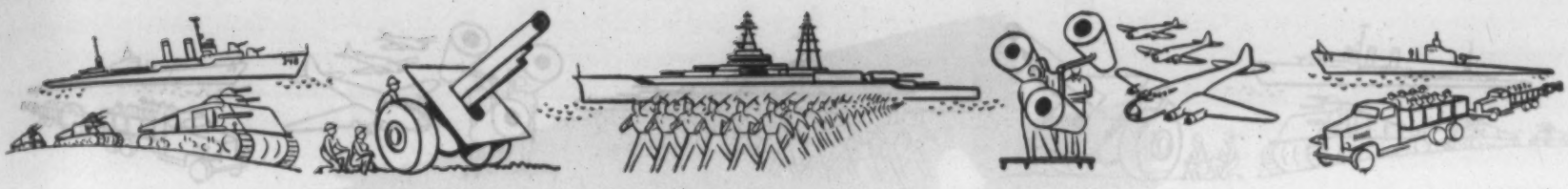
For the present China needs data essentially practical in nature (shall we say, such as is published in METALS AND ALLOYS?) — articles on raw materials, iron and steel production, rolling, heat treating, welding, machining, foundry practice, and shop kinks and procedures.

Following this suggestion, the Steel Institute is dispatching text books and clippings from technical journals in 50-lb. bundles by airplane.

This backwardness is also noted among the Japanese, as revealed in this department, this issue, under the heading "Metallurgy of Captured Equipment."

17 Engineering Societies Meet

"The Germans would have won the second world war if they had taken more time and accumulated more weapons and hit all surrounding nations simultaneously," stated Regi-



nald E. Gillmor, president, Sperry Gyroscope Co., Inc. before the conference of engineering societies committee on war production in New York on Jan. 30.

"The Germans are by no means through. They are now straining in the chemical, explosive and atomic fields. We've got to rush to beat them in the time element. Otherwise the Germans may yet develop the atomic bomb and defeat us.

"In case of Allied defeat we'd be an island in a world of war-torn frustrated people. Twice we have learned that unpreparedness is an incentive to being attacked. Let's hope we have learned our lesson."

Mr. Gillmor started his talk with the statement that gyroscopes are not the sole product of man. There are gyroscopes on the wings of the common housefly. Moreover, he doubts whether man, despite his creative mind, will ever catch up with nature on the matter of efficiency-weight. (In a previous issue we commented on the perfect radar equipment of the bat.)

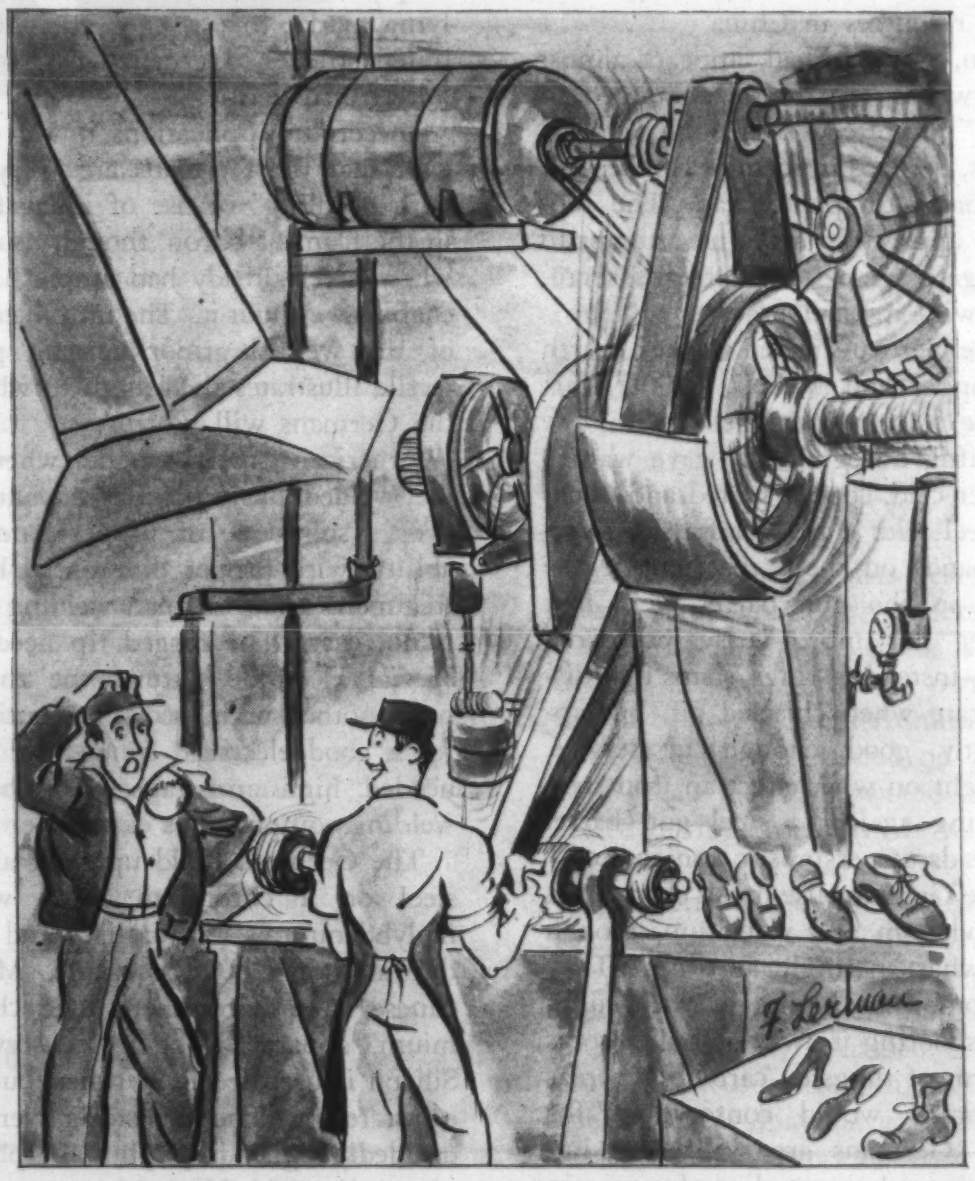
As to the panel meetings, we were particularly impressed by an idea advanced by Col. George S. Brady, Douglas T. Sterling Co., on advantages from good layout of plant facilities and economic routing of materials.

"Employees should see the product grow," he said. "When workers are divided into small groups and confined in small rooms, they lose the over-all picture of the progress of the product. Knock out the partitions and let them see the final product being assembled. This arouses their zest, spirit of team play and competition. It is inspiring to work in a large automobile plant where a chassis at one end of the assembly line emerges from the other end as a finished automobile.

"Plant lay-out is not a one-time job. It is continuous. The engineer should have cardboard models of equipment, sized to proper scale and constantly shuffle them around to study a better arrangement. A plant should use clever flow-sheets."

At one of the panels they discussed modern steel and metals for railroad rolling stock. The speaker always concluded: "The railroads will install it if costs justify it." We wonder sometimes if engineers look at costs broadly enough. For instance, in case of a light weight freight car, do they consider completely—not merely the initial cost—a host of other factors, such as less wear and tear on rails, less power to move, less time in the repairshop, etc.? We sometimes wonder if oldtime industries, such as railroads, are sufficiently bold, experimental and adventurous.

STRESS RELIEF By GILBERT

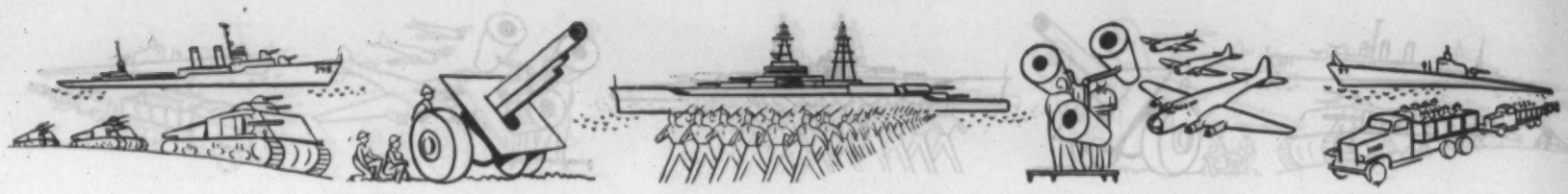


"I started this little side-line to help pay this year's income taxes."

Metallurgy of Captured Equipment

Studying your enemy is always an effective help towards winning wars. By examining closely captured enemy equipment one may get pointers in the field of metallurgy, engineering design and state of supply of major and alloying metals in the hands of the enemy. Germans apparently do not heat treat as much as we, at least with magnesium alloy castings, suggesting that perhaps Americans overdo heat treating.

Results of studies are contained in an interesting 32-page article in the February issue of *Metal Progress,* as written by J. R. Cady, H. W. Gillett and L. H. Grenell. Unfortunately, seldom is any mention made of enemy equipment later than that made in



1942. Since that year important changes may have been made.

The Japanese have apparently made no important metallurgical innovations, but copy the old formulas that are at least 10 years old. They are lavish in use of alloying elements, apparently having stockpiled copiously for years. They use tungsten especially liberally, possibly because of nearness to the world's largest natural resources in China.

Tin, as a residual, appears almost everywhere, apparently contained in scrap imported from the United States, perhaps in form of compressed and baled tin plate scrap. The Japanese apparently make no attempt to segregate scrap; the Germans segregate with meticulous care.

The Germans reveal marked dearth of copper and nickel. At the start of the war, copper shell cases were plentiful, but gradually gave way to copper clad, copper plated and, finally, steel with a lacquer finish. Driving bands on shells that engage the lands in the gun barrel were first copper but more lately powdered iron—instead of rings, strips that disintegrate when chiseled off, but apparently good enough in service. Thought on what effect an iron strip abrading against a steel gun barrel has leads to pessimistic conjecture.

The Germans use much chromium, molybdenum and vanadium, though somewhat sparingly at times. They are somewhat profligate with tungsten, shooting it away as bullet cores in form of tungsten carbide, whereas Americans would conserve it for tools. Germans are skillful at improvising when supplies of a certain element are scant. The Japs stick to their formulas, come hell or high water. German welding sometimes seems careless, but often they use it as a seal rather than a joining medium.

Germans are bold in innovations. Thus, an airplane front cam follower guide contained 5.5% Ce, 1.5% Mn, balance magnesium, which holds strength at elevated temperatures and is perhaps used because of ease of forging. Some of their innovations are a bit shocking to an old-line materials engineer, but since service tests show the materials usable, the Germans care not about theory.

The Japanese are woefully ignorant apparently on certain modern American practices. By spectrographic analysis an American can soon segregate mixed scrap. Japanese will make a beautiful articulated rod for an aircraft engine, then stamp it deeply with steel stencils with identifying marks, thus setting up concentrated stresses. Germans mark with ink or etch lightly.

In certain applications it was evident that the Germans are "playing with needling" or use of intensifiers in the form of boron, though usually where steel already had ample hardenability without it. The introduction of the welded armor-piercing projectile illustrates the length to which the Germans will go.

American experts wonder whether the welded projectile has advantage over a solid one of proper hardenability, with proper differential heat treatment. The German welding job is not easy. The forged tip needs a special electrode fixture, the rolled base another, with special precautions for a good electrical contact for the needed high amperage. The butt-welding equipment is expensive.

The Germans build up their alloy steel on a chromium basis, with molybdenum as an auxiliary and indications of a huge stockpile. Manganese is less prominent than chromium, apparently being conserved. Silicon is used freely at times, but as a last resort. The Jap steels average decidedly higher in sulphur and phosphorus than the Nazi.

Apparently the Germans resort to a die forging that would ordinarily call for a succession of dies. But they cast a slug roughly to shape, using but one die. German workmanship as to finish and dimensional tolerance is consistently mediocre though usually adequate for the use intended. Much hand labor goes into Jap work—and German, too.

Super-Duper V-Weapon

Army Ordnance has at last invented a secret weapon to put an end to all previous secret weapons. Tentatively called V-S, it may prove more powerful than that dream of inventors—the atom smasher. The launcher of this weapon waves a stick and chants; "A-one, a-two, a-three" —and the missle bursts—into song. The "S" in "V-S" means "song."

The ditty is "Ordnance Cannon March," in four flats, march tempo, 6/8 time. We quote the chorus:

"Ar-my Ord-nance-will always
Speed arms for vic-to-ry!
Toil un-til the world is free!
Ar-my Ord-nance for-ev-er
Guards the light of lib-er-ty!
We've gath-ered here, so rise
and sing!
Let's give a cheer and make it
ring—
The Ar-se-nal of De-moc-ra-cy!"

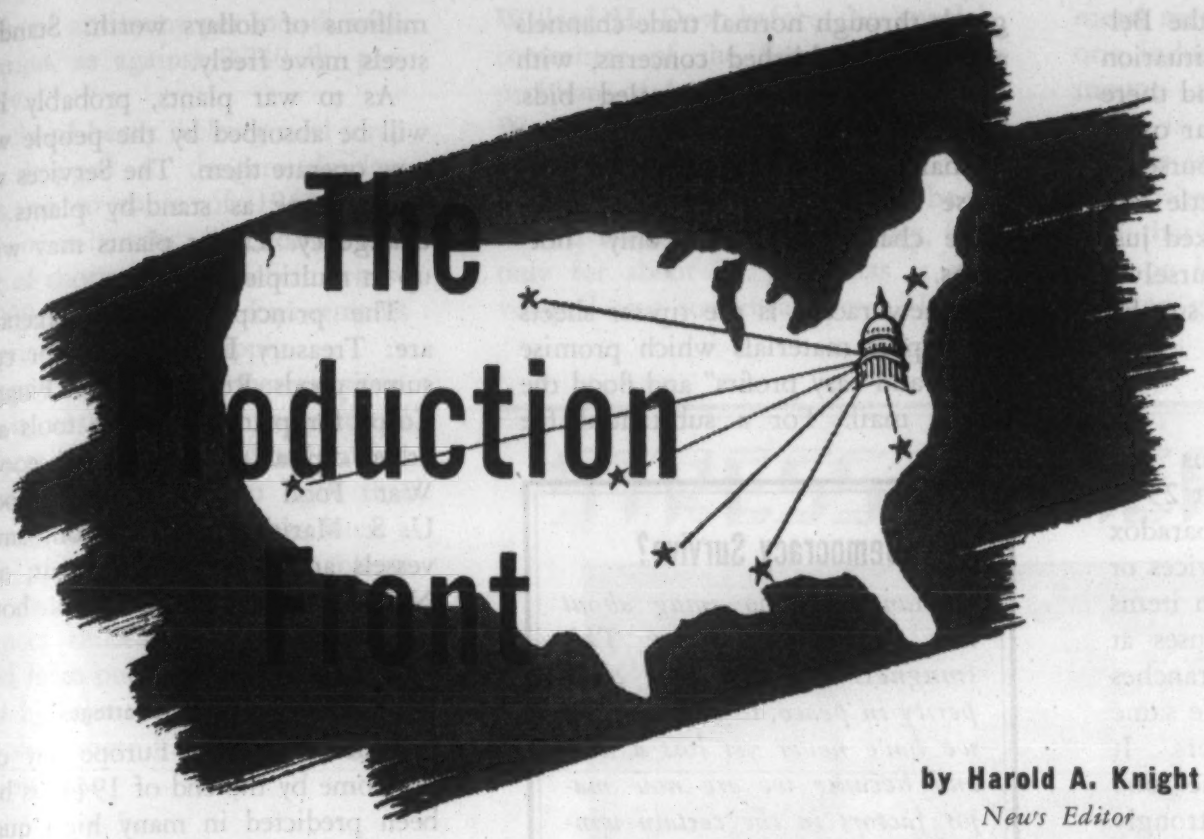
The march is dedicated to Col. W. E. Larned, commanding officer, Picatinny arsenal, and Mrs. Larned. It is suggested that the march be played and sung at all functions of the Ordnance Dept. and Army Ordnance Assn. "wherever occasion provides."

We recall a famous saying: "We care not who makes a nation's laws as long as we know who makes its songs." And a song of first world war days: "If he can fight like he can love—then it's goodbye, Germany."

To the latter we might add: "If Army Ordnance makes tanks like it makes songs, then goodbye to the whole cock-eyed Axis and sympathizers."

469 Conventions Denied

Out of 484 applications for approval of scheduled conventions or meetings that came between Feb. 1 and Feb. 9, the War Committee on Conventions denied 469 applications, and approved only 15. Those denied include technical and educational societies, medical, banking and bar associations, chambers of commerce, fraternal bodies, trade associations, women's clubs, youth organizations, veterans associations, and agricultural, religious and labor groups; also festivals, trade shows and market weeks.



by Harold A. Knight
News Editor

Peace goods conversion 15 to 20% after V-E day against previous estimates of 40. . . . Armed Services to need brand new equipment against Japan. . . . Optimistic predictions of our leaders often merely a poker game. . . . Thus Admiral Halsey out-bluffed the Japs. . . . Surplus war goods at war's end may be 50 billions of dollars. . . . We're selling much surplus now.

Anti-personnel mines sold for chicken feeders. . . . Present surplus of 20 millions merely "peanuts". . . . Regular trade channels to handle items. . . . Special alloy steels hard to sell. . . . Among metal shortages are carbon steel, copper, zinc, lead, tin, antimony and steel scrap. . . . Antimony used for cotton duck and battleship paints. . . . Manpower shortage exaggerated. . . . Technical men miss their conventions.

Many skeptical as to whether Democracy can survive. . . . Interesting facts about magnesium. . . . People slow to accept new products—Andrew Carnegie long favored wrought iron over steel. . . . U. S. to use 63 million lb. of "mag" yearly. . . . Our cartoon touches on a horse-and-buggy-day product. . . . We present three anecdotes of the hour. . . . Decentralization. . . . Government cracks against foundries.

Mostly Brand New Equipment for the Pacific War

The fall of Germany will result in not more than a 20% conversion to peace goods, in the opinion of William L. Batt, vice chairman, WPB, while certain other Washington authorities make the figure as low as 15%. This compares with 40% as a Washington estimate before the "Belgian bulge" and 70% estimated by a prominent automobile industrialist, as mentioned in these columns previously.

When our fighters in Europe are transferred to the Pacific, they will in large measure need brand new and different equipment, Mr. Batt points out. Men fighting in the tropics and many parts of the Orient require different clothing than servicemen fighting in northwest Europe. Weapons designed for the fairly good highways and rail transportation of Europe are not necessarily adapted to the primitive conditions in the Far East.

Just the mechanical job of cleaning, repairing and packing much of the equipment so that it could be shipped to the Pacific is an "appalling" job and often not practical. Mr. Batt further said that the Japanese army is numerically as large as the German army was at its peak and has completely unknown powers of resistance where it fights in tremendous masses of men.

Poker, or "Psychic" Bids in Bridge

Yet when the layman hears such drastic statements one wonders whether the speaker is sincere or is bluffing the enemy or even our own side. It will be recalled that Admiral William F. Halsey, Jr. stated on Jan. 1, 1943 that the Axis would be defeated during that year. It was later explained that it was a bit of poker playing on the part of Admiral Halsey. It was uttered originally during our darkest days of naval weakness. Halsey, by making such a bold statement, apparently confused the Japanese about our strength, or lack of the same. It may have warded off attack, when such an attack might have been fatal.

Possibly predictions by Eisenhower, Montgomery, Churchill, et al, that the Germans would be licked by Christmas 1944 was designed as a bit of poker playing. Trouble is that, as in a bridge game, a bluff bid by one may fool the partner worse than the opponents. We wonder now if the Japs are really going to be as tough as men like Under Secretary Grew and some of the military insist?

We Americans often overempha-

size trends. At the time of the Belgian bulge we regarded the situation with too much seriousness, and there is the chance we are today far overproducing, though that, of course, is a better failing than "too little and too late." An authority remarked just the other day we'll find ourselves with ridiculously stupendous surplus materials at war's end.

Surplus War Goods to be Colossal

Mr. Batt estimates surplus war goods on hand at war's end at 25 to 50 billions of dollars. One paradox is that one branch of the Services or Government is placing certain items in the surplus goods warehouses at the same time that other branches are placing fresh orders for the same goods with the manufacturers. It resembles the confusion in the food situation where it has been strongly advocated that one man be placed at the head.

Our surplus goods disposal officials are working feverishly to get such goods out of warehouses and to civilians immediately to make way for the tremendous stocks to arrive later. They are even trying to dispose of items left over from War I, such as horse-drawn ambulances.

Silver spurs to the extent of 30,000 have been sold to sponsors of the Heigh-Ho Silver radio program. There are such items as jackasses, pigeons, trucks, crane booms, shot guns, cartridge belts, bolts and nuts and hand grenade aprons.

Some clever adaptations to peace use have already been made. Anti-personnel mine containers have been adapted to chicken feeders. It is suggested the shot guns (used to train aviator gunners in flexible gunnery schools) be sold for a certain kind of weddings!

Who would like a nice pair of homing pigeons? But you'll have to keep them confined — otherwise they'll fly to their Signal Corps home. You can use them only for their eggs and offspring, the latter knowing no Army home. Present surplus war goods are valued at $20,000,000, but we were told this is merely "peanuts" by comparison with the final showing which will bulge out of warehouses worse than the Belgian bulge and tax the facilities of all outdoors.

Would Sell Through Normal Channels

Officials are trying to sell the goods through normal trade channels and well established concerns, with the tendency towards sealed bids. Speculators are usually avoided, but in many instances are dealt with because of the tendency of regular trade channels to want only "hot" items.

A new racket is the tipster sheets on surplus materials which promise "large and easy profits" and flood the public mail. For a substantial fee these promise "inside information" that will get purchasers in on the "ground floor." But they offer nothing that a business man cannot get himself by inquiring at a disposal agency.

Difficult to dispose of are the many special steels, of special alloys and heat treatment, of which there are millions of dollars worth. Standard steels move freely.

As to war plants, probably half will be absorbed by the people who now operate them. The Services will retain some as stand-by plants for emergency. Larger plants may wind up in multiple tenancy.

The principal disposal agencies are: Treasury Department, for consumer goods; Reconstruction Finance Corp., for plants, machine tools and other capital and producers' goods; War Food Administration, food; U. S. Maritime Commission, small vessels and marine equipment; and National Housing Agency, war housing property.

New Era of Basic Metal Shortages

When Victory-in-Europe day did not come by the end of 1944, as had been predicted in many high quarters, and when it became evident that our production would have to be stepped up as never before, it was predicted at Washington that we would have a new era of shortages of basic materials. These predictions begin to become evident.

Manufacturers of consumer durable goods must operate during second quarter with 23½% less carbon steel and 10% less copper than for the first quarter. In carbon steel total allotments are being cut over 1,000,000 tons. Zinc has become tighter and allocations among users more severe. The Government has placed new and tighter controls over tin as the stockpile has reached a "dangerously low level." Imports fall 25% short of the nation's needs. Meanwhile, the U. S. is paying Bolivia 63 cents per pound for tin as against 60 cents previously.

Government stockpiles of lead are down to 60,000 tons as against 90,000 tons at the start of this year, although the situation should be better by June 1 when supplies from Australia and Argentina should have arrived.

A scarcity that has received no publicity is antimony, where stocks of "regulus" are down to 1,000 tons, whereas a recent month's demand was 1,500 tons. This metal makes fire-proof cotton duck for tents and tarpaulins, and is an important ingredient of battleship paint. It has been suggested that instead of alloying antimony with lead for storage battery grids, calcium be used. New WPB orders allow purchase of only

Democracy Survive?

Many are too smug about this democracy of ours. This smugness is due to our prosperity in peace, to the fact that we have never yet lost a war, and because we are now major factors in the certain winning of the greatest, most difficult war in history.

Yet he who could have listened to a recent talk by Chester Bowles, director, OPA, would have had that smugness dented—perhaps turned into general alarm. He said that a famous and level-headed Swedish writer had recently sized up American democracy in a book and that his conclusions are not reassuring.

The whole world is watching us and is apprehensive as to whether our democracy will stick. If we divide up into groups and fail, we'll be the laughing stock of the world. We'll be insecure ourselves and tough for other nations to live with.

Mr. Bowles believes that this Swedish writer misses the flexibility of the United States and its ability to unite and learn necessary lessons under pressure. We are even now determined to reach the goal of necessary production to afford necessary employment.

224 lb. of antimony per month with allocation, as against 2,240 lb. previously.

Stocks of heavy melting steel scrap have dropped to dangerously low levels, or to those of 1942 when some open-hearths shut down because of shortage. The deficit is now 250,000 tons between requirements and present monthly supply.

Apparently our manpower situation is not as critical as pictured by those hysterically-inclined a few weeks ago. It comes to light that in many instances there has been a waste of manpower. Many plants have hoarded workers; in several instances thousands of workers released from one plant have not been hired by others in the same locality; and often there has been loafing on the job.

Strike Record "Good"—On Paper

Contrary to what the average citizen who reads the newspapers may believe, labor's strike record is quite remarkable (and on the favorable side). "Instead of increasing, the number of man-days lost to strikes has declined over the period 1942, 1943 and 1944," states no less an authority than J. A. Krug, head of WPB. Thus, in November 1944 only 0.1% of available working days were lost because of strikes. Such strikes as still occur are of shorter duration and involve fewer workers.

Many members of technical societies are feeling the hardship because of the ban against conventions and the lack of exchange of technical information. So far the Office of Defense Transportation has been tough in sanctioning conventions—a small March of Dimes convention and one of the Red Cross being the record to date. Congressmen become especially indignant when religious groups are turned away.

Progress since the first World War is measured in part by these facts: The 75-mm. gun of War I weighed 1,015 lb. against 410 lb. today—a direct measure of improved metallurgy. The range of our artillery in general has been increased 40 to 50% over that of War I.

Magnesium — In a Nutshell

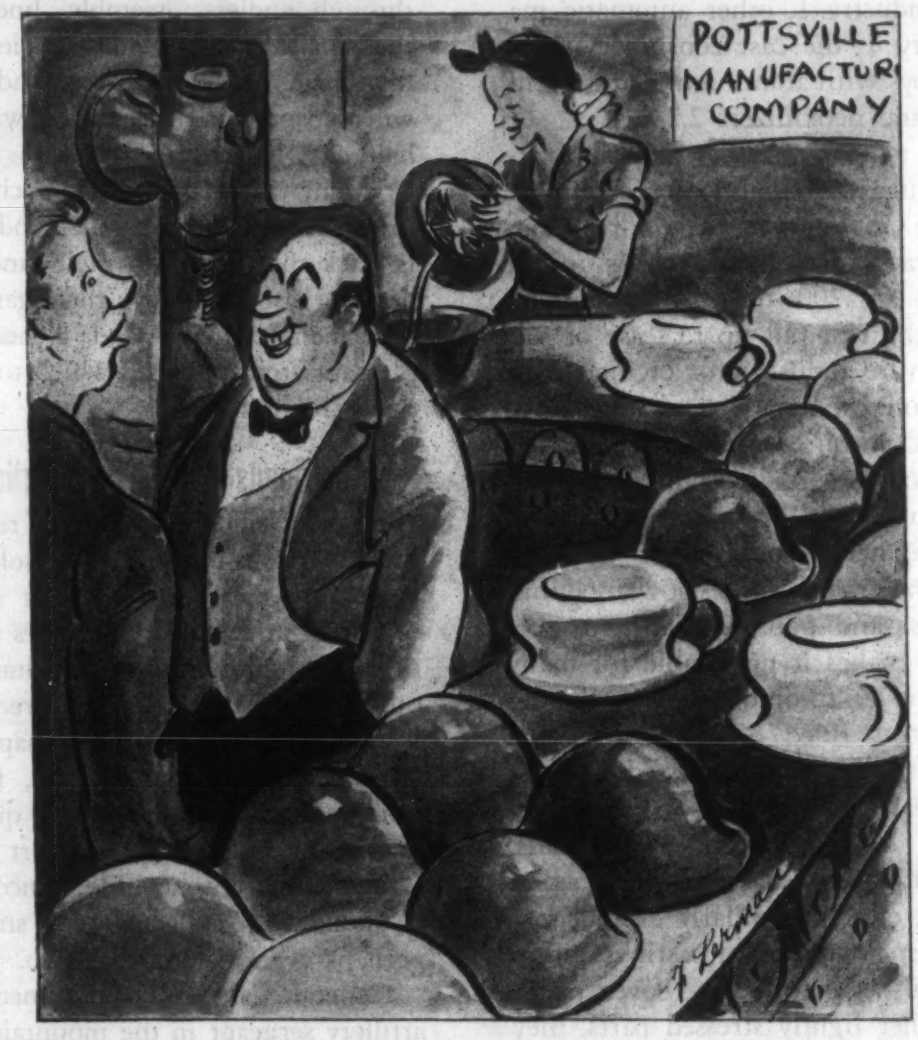
Not for a long time have we seen so many interesting facts concerning magnesium crammed into one presentation as that delivered by Dr. Willard H. Dow before the special committee of the Senate to study problems of American small business. We quote excerpts and paraphrase other sections.

"Magnesium as a metal has been known for more than a century, but only for about 25 years has it developed as a structural metal. It remained as a curiosity except for its use in flares until it was discovered that, if other metals were mixed with it, the alloy gave magnesium a new character and it became a very tough, but easily machined, corrosion-resisting metal.

"The public in the past has not accepted new products quickly. Andrew Carnegie believed steel was inferior to wrought iron as a structural material, and fought steel as long as he could. Until a few years ago weight has always meant strength. It took steel a long while to be accepted; aluminum is not yet wholly accepted, and it is not strange that the baby metal magnesium is accepted only in one industry where weight is paramount—the aircraft industry.

"It is useful to know that magnesium is available to us in limitless quantities, either in ores or in brines, and that the only limit to our production is the amount of electricity we can generate."

STRESS RELIEF By GILBERT



"WPB ordered us to sandwich in our essential peace product."

During 1941 production was 32.5 million pounds, all from Dow. Since then the Defense Plant Corp. has financed construction of 13 producing plants, with the U. S. capacity now 600,000,000 lb. yearly. Fabricators number 91, some wholly or partly owned by D.P.C. The realized production in 1943 was 374.6 million pounds; in 1944, 336.6 million. Consumption in 1943 was 332.2 million; in 1944, 316 million. In each year structural uses, mostly for airplanes, absorbed about half.

Production of magnesium has exceeded war consumption and at present 10 plants, with 85% of total

capacity, are shut down, with a stockpile of 100 million lb.

"We are guessing that the country will be using 63 million lb. about the fifth year after the close of the war. Consumption ought to rise rapidly after we pass the 50 million mark, for the uses will sprout other uses.

"We are planning a consumption, broken down as follows, in millions of lb.: Aircraft 28, textile 6, manually handled equipment 5, oil field industry 5, automobile die castings 5, busses, trucks and trailers 2, printing industry 1, other automatic machinery 1, die cast consumers goods 5, alloys with aluminum 3, and chemicals and deoxidizers 2."

As to our present surplus plants, it is suggested that some be retained by the Government as stand-by plants for war emergency, perhaps to the extent of 200 to 300 million lb., with the rest put up to lease or sale to private industry for civilian uses.

Before the same Senate Small Business Committee there was further testimony on magnesium, and other light materials, by J. S. Laird, chemical engineer, Ford Motor Co. He said that magnesium's low modulus, softness and poor resistance to corrosion makes it unsuitable for many parts of an automobile or farm tractor. It is ruled out for all engine parts that are highly stressed, or must be wear resistant; also for water-cooled cylinder blocks and heads. Transmissions, chassis frames, axles, brakes, etc. are similarly excluded.

Where magnesium castings might be used, as in oil pans, cover plates and other lightly stressed parts, they must compete with steel stampings or with aluminum castings. Here "mag" is at a disadvantage from cost —raw material and producing castings, offset slightly by ease of machining. Magnesium sheet in body work is hampered by lack of suitable welding processes. In automobile production one cannot capitalize on its light weight, as is done in airplane production.

But perhaps Dr. Dow visualizes the overcoming of many of these present disadvantages.

Decentralization of Industry

"There are in Ohio more than 200 communities under 10,000 population that have one or more industries. Some of these have grown from little more than corner blacksmith shops and are today employing 10 or 20 workers. They are fashioning parts of war equipment, which in turn are assembled in the larger central plants. This decentralization is desirable, and we'll see more of it in the future."

So spoke T. M. Girdler, chairman, Republic Steel Corp. and Consolidated Vultee Aircraft Corp. Continuing, "I doubt that post-war industry in America is going to build tremendous factories in the cities but establish assembly plants in localities which serve localized markets. It will draw through endless 'assembly' lines on the smaller plants and factories for raw materials. American industry will expand until great areas will be half city, half rural.

"Many of the workers in such factories live on farms. When industry is slack they work on their land. If nothing else, they have their gardens and their chickens and a healthy, pleasant atmosphere in which to rear their children."

Americans Can Always Smile

It is often said that the reason the Americans are such good soldiers is because they have the best sense of humor anywhere. One notes from news photographs the many humorous signs they invariably erect in newly-occupied territory. Perhaps we on the home, or production, front can well emulate their ever quickness-on-the-trigger to convert the serious frown into a smile. Since our last issue we've collected a few smiles, perhaps even a guffaw or two.

General Campbell questioned an artillery sergeant in the mountainous Italian theatre on ammunition supply. The sarg snapped to attention, beetled his brows, and replied: "Sir, I would describe the present ammunition supply in this sector as a lack of abundance."

As to the following anecdote, we don't think the woman involved was as much of a sap as might appear on the surface. Perhaps she had once worked in a ball-bearing plant where she wore non-lint producing clothes, could not wear nail polish, lest it contaminate the product, and had to keep fingernails cut close lest they scratch the metal. At any rate, it was evidently regarded as funny by Col. T. C. Gerber, field director of ammunition plants, who tells it.

This woman in slacks in a TNT plant never talked above a whisper. One day a fellow worker, imagining laryngitis, asked her how her throat was getting along. It developed she had talked in whispers lest she explode the TNT. She had doubtless formulated her own sonic principles, as they related to TNT. Or was it merely awe in the presence of the all-powerful?

We are indebted to that gossipy human interest publication, *The Houghton Line*, for the following—a true story. It seems there was a "charming little wartime widow" whose husband is a navy lieutenant (j.g.) stationed in Trinidad. After a long spell of lonesomeness she burst in upon a friend with: "Bill just writes that wives are to be allowed in Trinidad. I'm going by next boat." But time passed. The friend encountered the enthusiastic wife again and asked why she was still in the States. "Her face twisted into a smile reminiscent of the Mona Lisa," relates the official version of the story. "Very softly and sadly she said: 'I'm not going—I read Bill's letter over again next day and discovered Bill said "Waves"—not "wives".'"

Government Whacks Foundries Again

Very much in the limelight in recent months has been the shortage of workers in the foundries. Government agencies have publicized this situation and suggested that poor working conditions and pay were largely responsible. Foundry owners have countered with the statement that if the Government wants higher foundry production it better not advertise poor working conditions.

Well, the Government has done it again! In a Government publication appearing at mid-February it is pointed out that the foundries making cast iron boilers and radiators have "intolerable" working conditions, which cause a high rate of pneumonia, tuberculosis, silicosis and industrial accidents.

The Labor Advisory Committee of WPB has recommended: Ventilating systems, proper heating of foundries, lockers to keep clothes dry, showers and washrooms, lunchrooms, sanitary toilets, safety regulations, active labor-management committees, higher wages, training programs that fit men for promotion, and distribution of contracts in accordance with what any one foundry can do.

by Harold A. Knight
News Editor

We had thought world was improving. . . . We came down with a thud at the German atrocities. . . . All the more reason for U. S. to get tough and stay so. . . . We'll have to keep on our toes in preparedness and armament. . . . 70% European equipment to go to Pacific. . . . Reduction of Army requirements on V-E Day 15 to 20%; later 40%.

Production gained fastest in mortars, navy rockets and aircraft. . . . Worst manpower shortages among basic materials such as brass, steel, lead and zinc. . . . We, the winner, saddled with heaviest debts. . . . "Scraping bottom of steel barrel." . . . Industry taking returned veterans—and liking 'em. . . . Hardest man-made material used for bullets. . . . They are in shell that is much lighter and faster.

Young engineer will encounter new element: cost. . . . Predicted prices of lead, tin, copper and zinc will rise. . . . Pressure to reduce aluminum price. . . . Far West has other things besides climate. . . . Population there up 240% while rest of U. S. gains 64%. . . . Sentimental peace-time story about corrosion. . . . Tin, nickel, beryl and other metals arrive by plane.

We've Got Tough—Let's Stay So

A fellow sort of thought the world was improving—at least in the social sciences, or man's regard for his fellow man. It has been only a comparatively few years that well organized nurses tended the wounded on battlefields and that the Red Cross has functioned to alleviate man's suffering.

The 12-hr. day in industry has given way to the 8-hr. day because of regard for man's endurance and welfare. Such things as Social Security, unemployment relief, et al, supposedly typified the more advanced state of civilization.

Somehow we accounted for the atrocities of the Japanese because they are only a few years from barbarism. European nations were never placed in the same category as the still socially immature Japanese. Europe has supposedly been the fountain head of culture, civilization and enlightenment.

But a fellow, who has been believing in all of this supposed progress of mankind along sympathetic and altruistic lines, certainly "comes a cropper" when he reads and scans pictures about the terrible death camps maintained by the Germans for political prisoners. Surely the Dark Ages one reads about in the history books, mouth agape and eyes a poppin', from the hideous things described, were no darker than what our G.I.'s, as well as Congressmen and newspaper editors, have recently witnessed.

And what we are coming to is this. For a few years at least, we must abandon our soft-heartedness, our easy-going characteristics, our golden rule precepts. We, as a nation, must really get tough, as our G. I.'s have already accomplished. Some months ago we quoted a history professor who said that the world's strongest navy should be in the hands of the most peaceful nation.

We must get tough and occupy indefinitely all the Pacific islands we have invaded, as Admiral Halsey recommends. We must get tough with the German prisoners of war we now hold, recently reported "as fat as hogs" from the better-than-civilian fare they have eaten. We must get tough, where necessary, with our own Allies. Goodness knows, Russia has been tough enough—and aren't we as good as Russia?

And—here it more directly affects the engineers—we must not let our Army, Navy, war plants and war weapon creative ideas get flabby, as they did after the first World War. Why, after we had completely armed

Guam, for instance, in a few years we sent ships to dismantle that isle—for fear we'd offend the Japs.

Keep a Hard Core of Fighting Potential

For many years we must keep on hand a hard core of fighting machines and know how as to their manufacture and uses. We must keep huge stockpiles of critical materials. We must appropriate good money to develop new weapons.

Having the power to wage a mighty war, if necessary, when that power resides in a benign old gentleman such as Uncle Sam, or John Bull, for that matter, is the best insurance towards the peace of the world. The Axis powers have proved their world-destroying proclivities. Now it is our turn to stay tough and hard for many years to come.

About 70% of American war equipment left over in Europe after the defeat of Germany will be brought out for use against Japan, according to present plans of the Army. The other 30% will be written off as not worth saving, or as material needed in post-war Europe.

The first combat troops to reach the Western Pacific from Europe will, in general, be supplied with new weapons fresh from the United States. It will take several months for the bulk of munitions from Europe to reach the Pacific. At that time, of course, pressure on American war production will be lifted to a great extent.

The reduction in Army requirements from the United States will be 15 to 20% in the first three months after V-E day, and about 40% before the end of 1945, according to James F. Byrnes, previous head of the Office of War Mobilization and Reconversion, in an official report to the President, Senate and House of Representatives.

Mortar Production Skyrockets

Included in Mr. Byrnes' report is a table on "Progress in Critical Programs," based on per cent of production increase from September 1944 to February 1945. Mortars are far out front, with gain of 200%, with navy rockets second at about 135%, and aircraft a close third at 130%. The smallest increase has been in army trucks, about 25%. The average gain for all critical programs has been about 60%.

"Labor shortages now affect not only plants making finished munitions but also those providing equipment, components and materials. Six months ago the production urgency list for man-power referrals included plants making 23 products, primarily manufacturers of finished items. Today the list includes 39 products, and the additions are largely basic materials, such as brass strip, steel, lead and zinc."

Tempered Plant Workers

You and I knew John Harum-Scarum in his late 'teens, slovenly of gait and manners, contemptuous of his elders, loud-mouthed and cynical. In time, the Armed Services got him. What a revelation when he came home on furlough a year later! Come another year and he was home for good, perhaps wounded and incapacitated for battle, but usually still sound for civilian living. An entirely different John H!

At first, industry, in a spirit of patriotism, was rehiring the J. H.'s. Soon they were finding it good economic policy. As the War Manpower Commission puts it: "Former servicemen are proving such capable and dependable workers that employers are seeking more and more veterans as potential craftsmen."

Bethlehem Steel has hired 21,000 of them, taking not only former employees but others. The fire and chill of the battle-front have tempered them to just as fine qualities as the steel which is quenched and tempered in their shops.

This augurs well for the calibre of our industrial workmen in post-war. They should wield authority, take authority from superiors, weather up under trying conditions, and be contented with their lot.

Winner Is Saddled With Highest Debts

Besides reporting cold facts, Mr. Byrnes is somewhat of a philosopher and keen observer of human nature. He says: "We are winning the war. No nation that has lost a war heretofore has had saddled upon it a public debt as large as the debt we as victors must pay."

And again: "What is necessary to win the war we will do, and as a Christian, humane people we will gladly do our part to relieve suffering and distress in a war-torn world; but in authorizing rehabilitation projects throughout the world and post-war projects at home, we must give consideration to the people of this country who will pay the bills."

Speaking of the shift of war activity to the Pacific, Gen. Brehon B. Somervell, chief of the Army's Service of Supplies, states that our nation is scraping the bottom of the steel barrel. A new steel crisis has developed because of the increased weight of bombs, plus needs for heavy equipment in the Pacific.

The civilian pinch, states General Somervell, will be felt primarily in steel, cotton goods and shoes. Shoes rot fast in the tropics and civilians may be cut to one pair a year.

We Shoot Our Tungsten Away

"Germans have had tungsten to shoot away, for certain very high velocity armor-piercing projectiles carry a core made of tungsten carbide!" Such was a statement in an article on "Enemy Matériel from the Metallurgical Point of View", by J. R. Cady, H. W. Gillett and L. H. Grenell, digested in this department, March issue. The article went on to say that in the U. S. early in the war tungsten for high-speed tool steels was so scarce we raised the vanadium content and substituted molybdenum for part of the tungsten.

But now we are "shooting tungsten away"—and it looks as though we had copied the Germans again. But there is an old saw: "Gold is where you find it"—which holds good for a golden idea.

Tungsten carbide cores are being used by our Army to combat the new series of German Tiger and Panther tanks. Carboloy Co. started their manufacture last July. The extreme hardness of the carbide prevents its being flattened out on impact. Being both vastly harder and heavier than armor plate, it penetrates the plate far easier than could a steel core.

The core is virtually unmarked after passing through several inches of armor plate. After penetration, the core breaks up into lethal pieces, scat-

tering in all directions inside the enemy tank, often setting fire to the tank.

The design of the entire projectile is novel, an important feature being the much lighter total weight of the projectile, the housing being mainly aluminum. The prime function of the outer body is to streamline the shell and permit a small diameter armor-piercing core to be fired from a larger bore gun.

For the 76-mm. gun, roughly half the weight is in the core, the total projectile weighing 9 lb., as against 15 lb. for the conventional steel armor piercing projectile. Consequently, muzzle velocity is around 3400 ft. per sec. as against the conventional 2800 ft.

The aluminum windshield and body perform no function of armor penetration. Efficiency is increased by having its energy largely concentrated in the smaller diameter tungsten carbide core. In firing, there is higher accuracy because of higher velocity and shorter flight time. Tanks in motion can be hit with much greater ease.

Reports from the front indicate that German tanks have been stopped with a single shot at ranges up to 3000 yd. Actually, the new weapon is a projectile within a projectile, with the inner one of hardest metal yet made by man.

In the earlier part of the war, we needed all tungsten available for tools to make tanks. Now we can spare tungsten to destroy enemy tanks. Scrap tungsten carbide can be used in core production, and nickel has become plentiful enough to use as binder in place of the more critical cobalt. The cores can be produced to specification as to weight and size tolerances without subsequent grinding.

A new "ore-to-core" plant to produce these cores, costing $6,000,000, is being built at Natrium, W. Va. When completed, it will be the largest tungsten ore reducing plant in the world and will be able to process every type of tungsten bearing ore. In the same village is a chlorine plant, with hydrogen as a by-product, the latter needed for reduction of tungsten ores. The tungsten plant will employ 1200 at its peak.

An interesting observation in connection with the manufacture of the cores is that, despite the fact that the carbide is man's hardest metal, the cores are handled at one stage of manufacture in wooden "boats" lined with sponge rubber to protect them before they have hardened.

Future Design Element: Cost

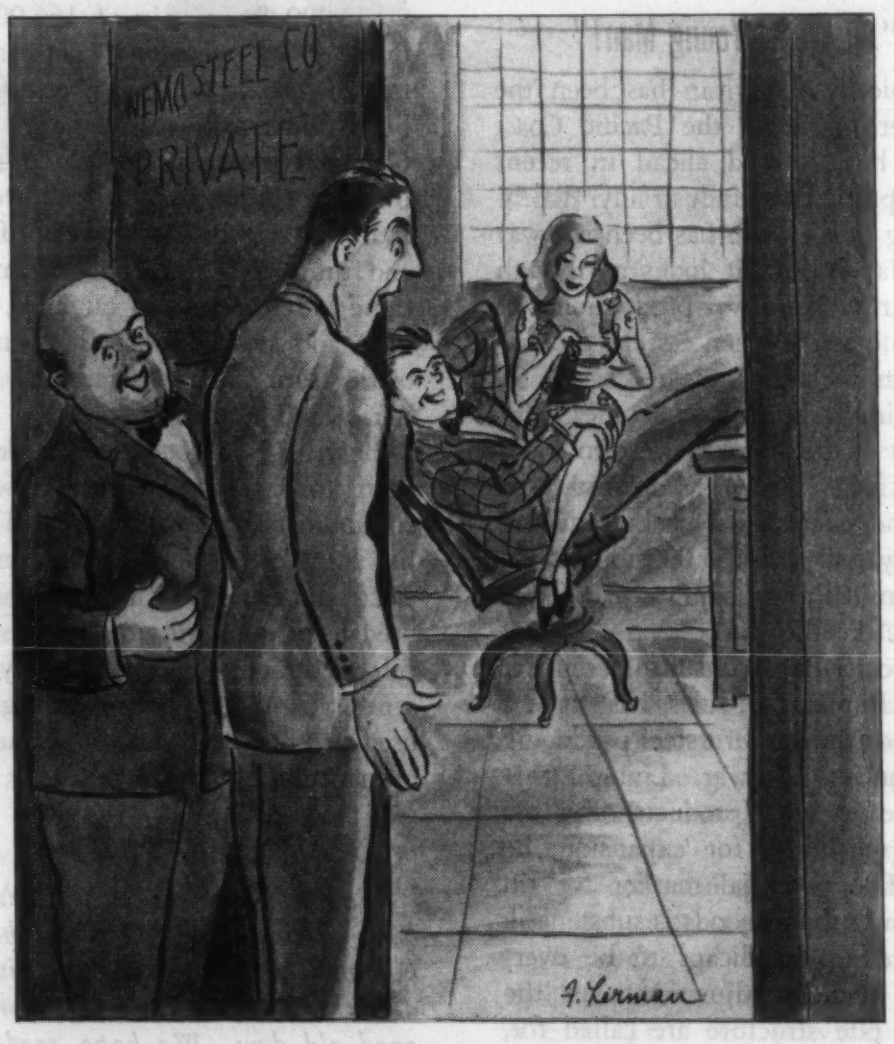
The young engineer in industry, fresh from school and not in the armed services, cutting his eye teeth on the merry-go-round of war economics, may wake up with a start in post-war to discover there is another element besides suitability or availability of raw materials. That element is cost. In the post-war it will not matter solely whether the material can be easily stamped, rolled, drawn or die cast—but in large measure how its cost will measure down alongside competing materials.

As the wars approach their end or climax, one hears more discussion of the element, cost. The imposition of ceiling prices has thrown present selling prices into a false light as they relate to actual values. Prices of most of our metals have not changed since Pearl Harbor. During the previous war they rose an average of 100%.

So, when ceiling prices are banished, there may be a scramble of readjustment of prices. We sat in with a group of serious thinkers along metal industry lines the other day and they named three metals whose prices will undoubtedly rise, mentioned in order of certainty: Lead, tin and copper. To which zinc was added by another metal price authority we talked with.

On the other hand, we have encountered considerable pressure towards reducing prices of light metals. Speaking about aluminum, Maury Maverick, chairman, Smaller War Plants Corp., told the Senate Small Business Committee: "Government research, competition, a few court decisions, public discussion—will, in my opinion, bring a lower price of

STRESS RELIEF By GILBERT



"I've finally gotten Junior to take an interest in the business."

aluminum. Though aluminum producers have made great advances, I do not believe they can envision the huge development of big and little business with cheaper aluminum."

Before the same Senate committee Executive Vice-Chairman Hawthorne of the Association of American Railroads expressed the hope that light metal prices may be cut for the sake of the railroads. He said that the carriers, while fully appreciating that there is no profit in hauling unnecessary dead weight, see no economy in paying too much premium for weight saving, either in first cost, increased maintenance, or reduced life of equipment.

"Go West, Young Man!"

Typically American has been the manner in which the Pacific Coast states have forged ahead in recent years, particularly industrially. Accentuating this growth has been the war with Japan, and it looks as though this Far Western war production will continue active when eastern production has in large measure ceased.

During the past four decades, population of the 11 most western states has increased 240% as against 64% for other states. Its steel producing capacity now is 4,655,000 tons of ingots annually as against 2,019,000 tons before the war.

H. Foster Bain, consulting engineer of the Bureau of Mines, has made a survey of the western steel producing situation in post-war. Light, rather than heavy, steel products offer the best opportunity for expansion, he says. The potential market for tin plate and tubular goods is substantial.

There are handicaps to be overcome. Radical adjustments in the freight rate structure are called for. There are certain harmful impurities in western iron ores; there are deficiencies in western coking coals and lack of markets for byproducts; also, a possible future deficiency in the local scrap supply.

Apparently the eastern steel companies appreciate the value of western plant and raw materials holdings, judging by the rumors of big companies jockeying for purchasing privileges. The long shipments of steel from East to West by rail and water in pre-war have not always seemed economic.

To which the Los Angeles Chamber of Commerce adds that steel prices on the Pacific Coast are $10 to $15 per ton higher than in eastern production centers. It urges local production in the Western states at lower prices in post war.

Apparently the Far West is becoming no longer merely a place for Iowa farmers to retire to for peace and quiet but a beehive of industrial activity. There is a new pride of the West developing similar to a new pride of the South, intensified by the South's industrial expansion. Perhaps Horace Greely's famous advice is still not out of date.

Strategic Metals Come by Plane

Strategic materials brought into the U. S. by airplane in 1944 totaled 7,133,000 lb., a gain of 166,000 lb. over 1943. Additional items arrived by ship from Calcutta after having been flown over the "Hump" from China. The largest single item flown in from China was tin, followed in order by hog bristles, bristle riflings, and tungsten. From South America came beryl, mica and tantalite, with mica and steatite from India, nickel oxide from Cuba and tantalite from Africa and Australia.

Beryl is, of course, a hardening agent for copper. Steatite is used in communication equipment. Tantalite is the ore of an essential metal in electronic tubes, and in oxide form is used in metal cutting tools and surgical instruments, and as a catalyst in synthetic rubber. Bristle riflings are used in preparation of leather and in ordnance.

Chapel by the Lake

(Fed up with the war, we'd go back to the scenes described herein but for lack of gasolene. We give an outlet to our homesickness for the good old days. We hope, reader, it will give you a moment of war relief.)

On the wooded shores of a lake where the Oneidas entertained the Senecas, Onondagas, Cayugas, Iroquois and Algonquins and smoked the pipe of peace, a chapel was built in 1888. The environs is rich in early American history. Rumor has it that a cannon stuffed with gold, which the British were transporting to pay the Hessians, is sunk in the river near its outlet into the lake.

Summer residents congregate in the chapel of a Sunday and it is a social center on certain occasions on week days. At the corner of the platform, which forms the pulpit, is the "corner stone" of the chapel in which were inserted at the time the edifice was built certain appropriate documents, such as list of charter members of the chapel, current newspapers of the day, a history of Central New York State and other fitting literature.

We were there when the members of the congregation were about to celebrate the fiftieth anniversary of the building of the little church. It was planned to break open the corner stone, remove the documents and read them at the ceremonies, then insert them for another 50 years. But first it was deemed best to open up the cornerstone to see that all was well.

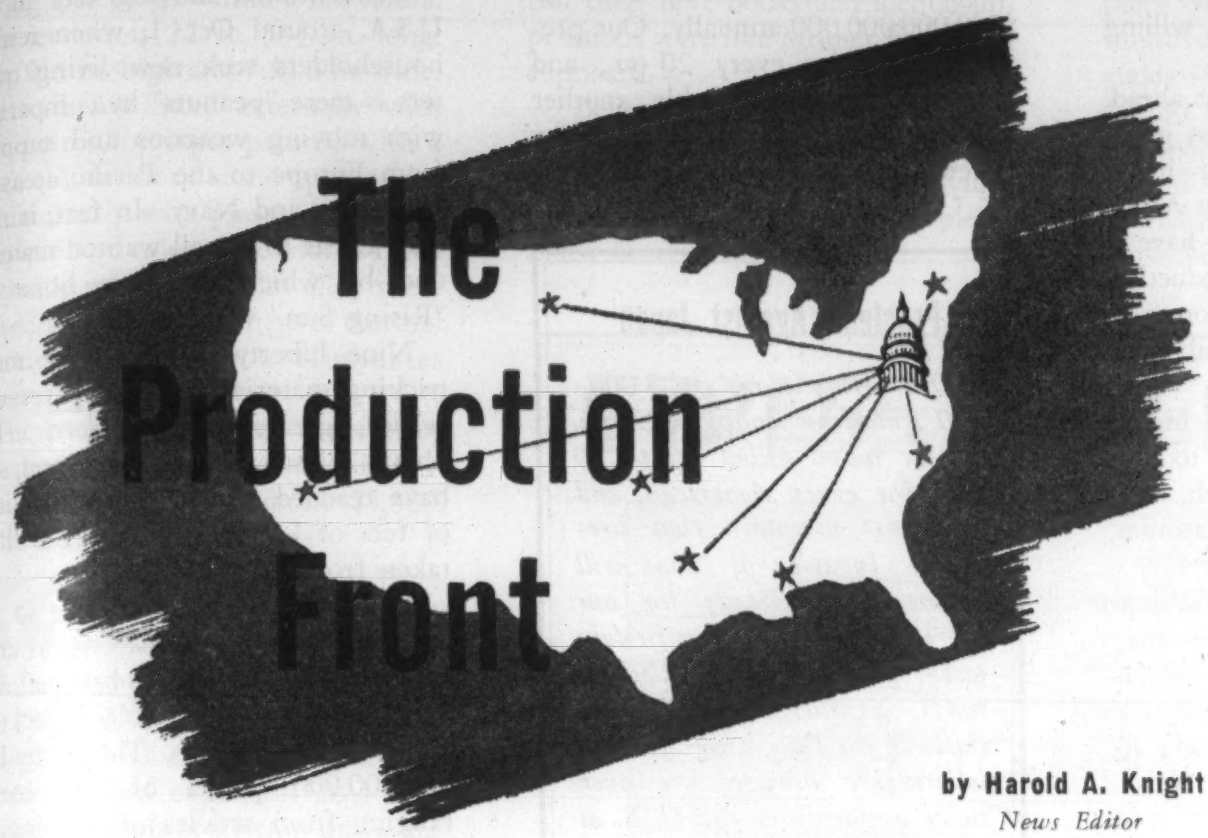
Now, back in 1888 steel rails were gradually replacing iron rails on the railroads; the American tin plate industry had not yet sprung up and all plate was imported from Wales. Two years later the Dingley tariff was passed to protect the proposed American tin plate industry.

So the evening before the official opening of the cornerstone, we accompanied the committee chairman and janitor of the church to make a preliminary opening of the cornerstone. We three were all a bit excited over what we should find there.

With the proper tools the janitor pried open the planks that concealed the cavity. Our curiosity intensified, only to be followed by disappointment. The documents had been concealed in a tin box, made apparently of the Welsh tin plate.

But there were only meager remnants of the tin box container. What greeted us were stained scraps of paper, dust, acorn shells and indications of animals. The squirrels had used the cavity, made available by the rusted box, as a nest in which to rear their young. There was not a single legible sign of what had originally been placed into the box.

Somewhat sorrowfully we covered up the metallurgical failure of a half century before, locked up the chapel and proceeded along our respective ways. Outside, gentle waves were lapping the shore. An owl hooted in the distance—or was that the ghost of Chief Sconondoah, scoffing at the foolish and futile Pale Face who thought that a tin box would preserve his relics over time?



by Harold A. Knight
News Editor

"Have we enough political maturity to handle post-war?" . . . "When the Army gets in trouble it spends its way out." . . . Washington like man recovering from severe illness. . . . At least optimistic enough to suggest: "A nation prominent in winning world's worst war should win the peace." . . . "Steel makers claim plenty of steel—when haven't they?" . . . Tight metals range alphabetically from antimony to tin.

We can place surplus machine tools into trade schools and arsenals. . . . Ship second hand tools abroad. . . . Framing of charters never runs smoothly. . . Our production should continue to double every 20 years. . . . Moving equipment from Europe to Pacific is "big business." . . . There are 100,000,000 pieces of equipment to be packed. . . . Many go to packing school. . . . British are erecting prefabricated aluminum houses, costing $3,600.

We burn our way to victory over Japan. . . . "Gel gas" burns longer and more slowly than gasoline. . . . In flame throwers, 90% of fuel formerly burned enroute to target—now 30%. . . . Japs visited our shipyards—so sorry! . . . Our problems as to Japan. . . . Comparison of reciprocating engines, jets and gas turbine-propellers in aircraft. . . . Our cartoon might be captioned: "Personnel." . . . Uncle Sam devises short cuts.

Washington Sings the Reconstruction Blues

"I'm scared whether we've got the political maturity to handle the post-war situation."

"Germany can't be made merely a 'hewer of wood and drawer of water.' If we bear down too hard, the Germans may riot—all Europe may riot. We Americans may be very quickly disillusioned, feeling that we have been 'traded down the river again.'"

"Our problem in the Pacific staggers the imagination—the long distances to get men and supplies there, the terrific energy needed to beat the Japs and the years needed for homesick American service forces to police Japan."

"Remember when peace comes we'll have in a sense a more difficult economy than in war. An Army general recently said: 'When the Army gets in trouble it spends its way out.' Money won't be growing on trees when we awake to realities of a peaceful world in the wake of this war's holocaust."

These were the cheerful (?) sentiments we brought back from an active few hours in Washington, where we heard some dozen big wigs tell what's what. Each statement above was by a different person. They spoke to us to give us "background" —they refused to be quoted.

Apparently official Washington is like a patient in a hospital who has undergone a successful operation. He is beginning to recover from the shock and is feeling peevish and ill at ease. That very peevishness is a good sign. A feeling of complacency and indifference would indeed be alarming.

Even one of the most pessimistic of the above-mentioned Washingtonians admitted: "Surely the Allies who won the most difficult war in history can win a prosperous peace for the world."

Flat Steel Among Scarcities

Among the materials extremely tight in supply, we were told, are lumber, chemicals and textiles. Also, sheet steel and steel strip. "Oh, yes, steel makers say there is plenty of steel—but when haven't they said that?" one authority told us. There

is a tremendous export demand for steel. In fact, there are many millions of "hot money" abroad, willing to outbid American buyers.

In textiles there is no light ahead. We've got to solve the cotton problem—perhaps by importing it or cutting down shipments to our Army. Perhaps, in fact, we should have a month's holiday on total production of all goods for the armed forces to allow us to do some essential work for civilians.

WPB lists the following metals and minerals as tight and apt to continue so: Antimony, bismuth, cadmium, graphite, lead, mica, platinum, talc, tin, and certain ferroalloys.

As to surplus materials, Washington tells us that in the main they will be easily digested. The surplus of machine tools perhaps gives the most headaches. We have made 1,000,000 such tools in four years, whereas only 25,000 tools were sold in the best peace year.

However, during the war most tools have been used 24 hr. per day and often by inexperienced help and often poorly cared for. Relative average age of the tools is 15 yr. We must dispose of the bulk of them before V-J day, else a more terrific surplus will spring up.

There are 150,000 technical and trade schools that could well use many of these machine tools. Many technical colleges have acquired no new tools in 20 to 25 yr. Moreover, let's put new machine tools into all our arsenals, which in other peace periods have had only antiquated tools. The bulk of our worn and second-hand tools can be shipped to other countries. China, for instance, a nation of mostly hand labor, would regard such tools very favorably.

No Great Documents Harmoniously Compiled

It was pointed out to us that we must not despair too much of present great conclaves and documents, such as Bretton Woods and the San Francisco conference. What to us in the mellow light of history look like ideal documents, such as our Declaration of Independence and our Constitution, went through discouraging throes of formulation. In those days many dissenters tried to toss monkey wrenches. There was much give and take before the famous documents were completed as we know them today.

The best insurance against inflation is more and more production. The planners have in mind a production of goods and services by 1950 of $200,000,000,000 annually. Our production doubles every 20 yr., and should continue to double another 30 or 40 yr. (That was predicted by a New Dealer, though we had understood that one New Deal theory has been that the country has attained its full growth and that we're destined for a stagnant economy.) Such production will automatically take care of unemployment.

Problems Against Japan

Our Army plans on 3,000,000 American troops in China. So far we've killed 16 to 20 Japs for every American, and we must maintain that firepower. Invasion of Japan will be necessary. Ready for our use when we landed in Britain were ports, docks, railroads, roads, airfields, hospitals, etc. Bases in the Pacific we are now laboriously winning are over twice as far from the U. S. as England is from our East coast.

There are four main Japan islands, the terrain tough, tight and forbidding. Over two-thirds is mountainous, some 12,000 ft. high. Only a few strips of beach are suitable for amphibious attack. To land 250,000 men for 30 days, 1,889,000 tons of supplies are needed, with 283 supply ships for the initial delivery.

The Japanese language is hard to master, there are few roads, no food that we could use, no railroads, no communications. We can't win by bombing alone. About 65% of all manufacture is in plants of five or less workmen. Bombing often increases enemy determination and spurs output.

The Jap army is over 5,000,000. We have already killed 770,000, but over 1,000,000 have come of age to replace them. It will cost $71,000,000,000 to fight Japan from here on. They fight more savagely and fanatically than the Germans.

West Moves East

Conventional moving day in the U.S.A. around Oct. 1, when restless householders seek new living quarters is mere "peanuts" by comparison with moving weapons and supplies from Europe to the Pacific areas by our Army and Navy. In fact, it may take a year to get all wanted material out, by which time we hope the "Rising Sun" will have set.

Nine Liberty ships full of many packing materials such as paper, excelsior, greases and modern cellophanes, plastic coatings, silica gel, etc., have reached Europe, while millions of feet of lumber for crates will be taken from Germany.

The War Department has so far condemned but little material as unfit for moving—mostly obsolete and over-age ammunition, black neckties and cavalry uniforms. The Army has 100,000,000 pieces of equipment, ranging from articles of clothing to X-ray machines to recondition at 72 depots in Germany and France.

The Army has in the European theater 11,000 light and medium field guns, 350,000 automatic weapons and mortars, 3,000,000 small arms, 260,000 combat vehicles, and 371,000 non-combat vehicles. Only two of every ten in reconditioning work will be American soldiers, as 250,000 European civilians will be used.

A packing training center has been established at Nanterre, near Paris, and men from lieutenant-colonels down to privates will take a 7-day course at the rate of 80 men each week. Moreover, thousands of skilled German prisoners of war will help.

Fortunately, several ships laden with war supplies were stopped in mid-ocean on V-E day, turned around and came home. Our shipments to Europe hereafter will consist of food, clothing, etc. to maintain 5,000,000 persons in Europe, of which 3,000,000 are American soldiers, 2,000,000 prisoners of war, and 50,000 French soldiers.

Rebuilding of friendly devastated countries will be done chiefly with local materials. Meanwhile, Americans may learn much from the temporary housing ideas of the British, who intend to erect 145,000 prefabricated houses, which may be replaced in ten years by permanent homes.

Among the newer types is the "Airoh" aluminum house, made in four sections, each complete in itself.

The sections are coupled by interlocking fastenings within a few hours. Each section is 22 ft. 5½ in. long, 10 ft. 8½ in. high and 7 ft. 6 in. wide. The walls are faced externally with aluminum alloy sheet painted with a rough cast finish of stone appearance, and internally with plaster board and spray-painted color. The roof is faced externally with aluminum alloy sheet packed with cork, which gives thermal insulation and which eliminates drumming.

Three other types of emergency houses are made of steel. The aluminum house will cost about $3,600, with steel houses $2,800.

So Sorry, Mr. Visiting Japanese!

Following publication of an editorial, "Shall Aliens Visit Our Plants?," in our April issue, in which was mentioned a faked explosion at a steel plant as a means of getting unwanted Japanese the H— out of there, we have been informed of other incidents of a similar nature. Here, for instance, are some anecdotes that bring smiles, as told by one of our readers.

"Before Pearl Harbor and in the days of the 'defense program,' a delegation of Japanese visitors came to our shipyard. The general manager was not pleased by their 'honorable' visit, but their credentials were such that he could not refuse them the expected courtesies.

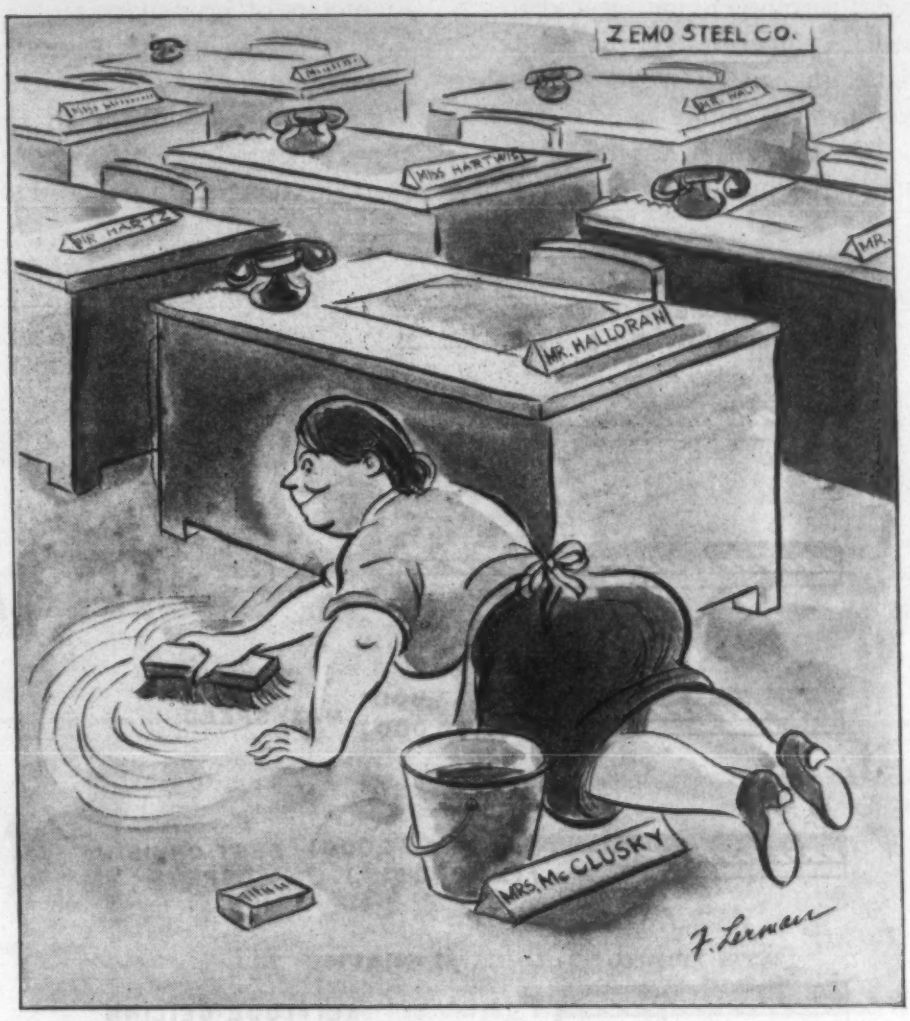
"So—much time was consumed in gestures of hospitality and good cheer in the offices. Then, somewhat tardily, the inspection tour began. The cafeteria, first aid rooms and various non-operative units were thoroughly inspected, and there was quite a little circuitous marching around the extensive yards.

"When they came to a ship under construction, most unfortunately a string of freight cars was on a siding in such a position to obscure the view. (So sorry!) And when they went through one of the machine shops where new type equipment was in use, painters were splashing paint on the ceiling, with all machines covered with tarpaulins. (Oh, so sorry!)

"And so, incident after incident followed, with the American guides most attentive and solicitous, but with the wanted information always just beyond Mr. Moto's and Mr. Sujo's grasp. The tired feet of the 'honorables' would have indicated they had been many places and seen much. But their note books and mental impressions were like Mother Hubbard's cupboard.

"Believe this if you want to, but our uniformed gateman heard Mr. Moto say to Mr. Sujo when leaving: 'Plenty walk, plenty talk, no-plenty know how, what?'"

STRESS RELIEF By Gilbert



"Personnel!"

Clubs, Arrows, Gunpowder —Now Fire

The early cave men fought each other with burled clubs. Then came the era of bows and arrows. At length gun powder was invented. During all of this time fire was known but it remained until about 1944 for it to be developed as a formidable weapon. It now looks as though we'd burn our way to victory against the Japanese. Use of fire has been one of the important innovations of this war.

Jellied gasoline, or "gel gas," is made by stirring a secret white powder into ordinary motor fuel, used in a new oil bomb, like a hexagonal piece of pipe, and in a greatly improved flame thrower. Gasoline yields 18,800 B.t.u.'s a pound against 10,780 for magnesium.

Gasoline alone spends its heat before it has ignited target materials, whereas the gel gas maintains intense heat for several minutes. The fire bomb ignites well at temperatures as low as minus 40 F., necessary for high altitude bombing.

After the bomb strikes, the charge of gel gas, encased in a cheesecloth sack, is hurled out of the tail for 100 ft. Early in the European war we used only 5% incendiaries; against Japan it is 100%.

In flame throwers, formerly 90% of the fuel burned enroute to the target; now only 30%. Besides, the new fuel can "go around corners," caroming around inside concrete pillboxes to do maximum damage. It is effective when thrown 150 ft.; previously, the G.I. had to stand within 50 ft. of target.

Jets and Turbine-Propellers

There's something about jet propulsion that appeals to the Buck Rogers instincts in most everyone. Until recently airplanes were driven only by reciprocating internal combustion engines. But two new types of airplane power plants will undoubtedly figure largely in aviation of the near future—the jet propulsion engine and the gas turbine-propeller drive. Both will have continuous combustion gas turbines as the prime mover.

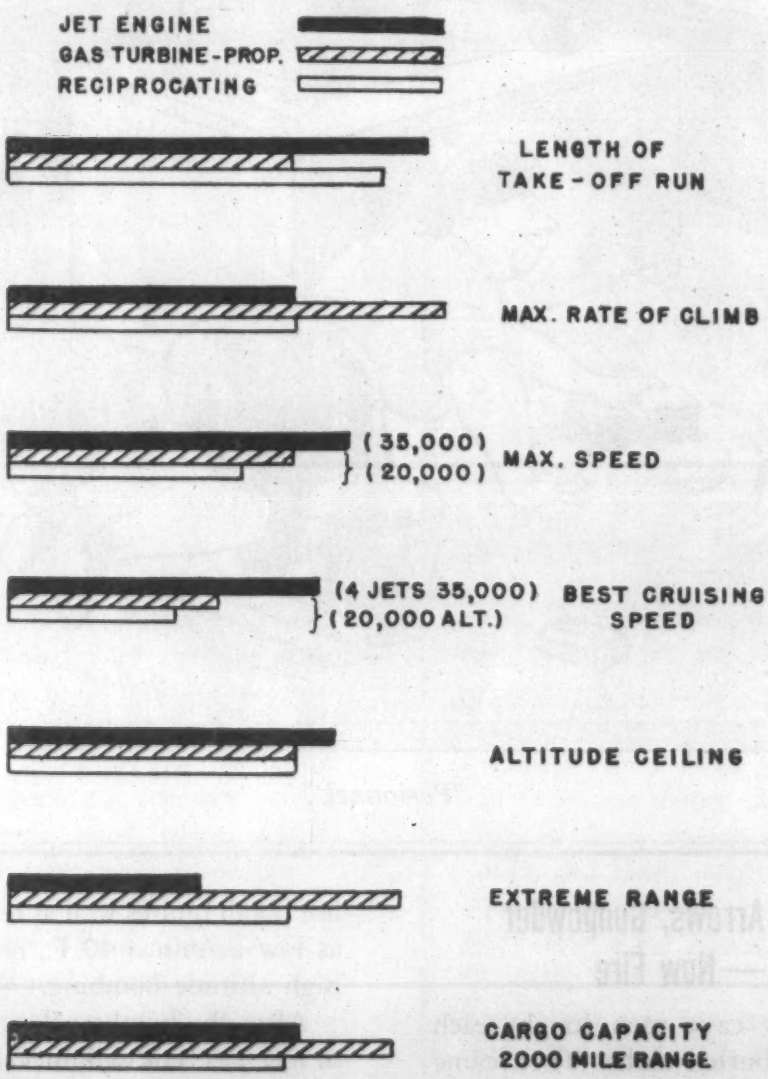
The gas turbine engine, geared to a propeller, is superior over the reciprocating engine in all speed ranges, and over the jet engine in low and intermediate speeds. The jet is preeminent in the highest speed range, or 500 m.p.h. or greater. The reciprocating engine is adapted to cruising flight rather than sustained high-speed flight. Principal advantages of the jet are its simplicity and light weight. However, present jet efficiency does not equal propeller efficiency until flight speeds of 500 m.p.h. are attained.

The installed weight of the geared gas turbine engine should be less than ¾ the weight of the equivalent reciprocating engine. The "recip" engine presents a dismayingly large frontal area when placed in a wing nacelle, thus making for severe drag, which is contrary to the turbine-propeller power.

The jet is superior to the conventional in all particulars save take-off, climb and range. With the turbine-propeller combination, however, research must provide size and weight reduction of present large spinner diameters of propellers.

The jet, being light, can get off the ground for very short flights, with 5 tons more payload than the conventional aircraft, and 3 tons more than the turbine-propeller. However, at 2000 miles extreme range the jet loses out to the "recip" and is far behind the geared turbine in payload carrying.

The jet bomber or cargo plane must be limited to relatively short range, very high speed, high altitudes, and be able to stand high fuel costs until we have learned more about the aerodynamics of flight at over 500 m.p.h. The turbine-propeller has immediate applications in all services at much above 1000 h.p. at usual flight altitudes, and should be ready for use when aircraft designs require 10,000 h.p. or more in a single power plant unit.



An interesting sidelight as to the force of the blast of exhaust gases from the jet are incidents in a large laboratory. A workman unthinkingly stepped into the exhaust stream and was thrown 300 ft. Though unconscious, he was not hurt seriously. A wooden packing case, thrown into the blast, was reduced to thousands of splinters.

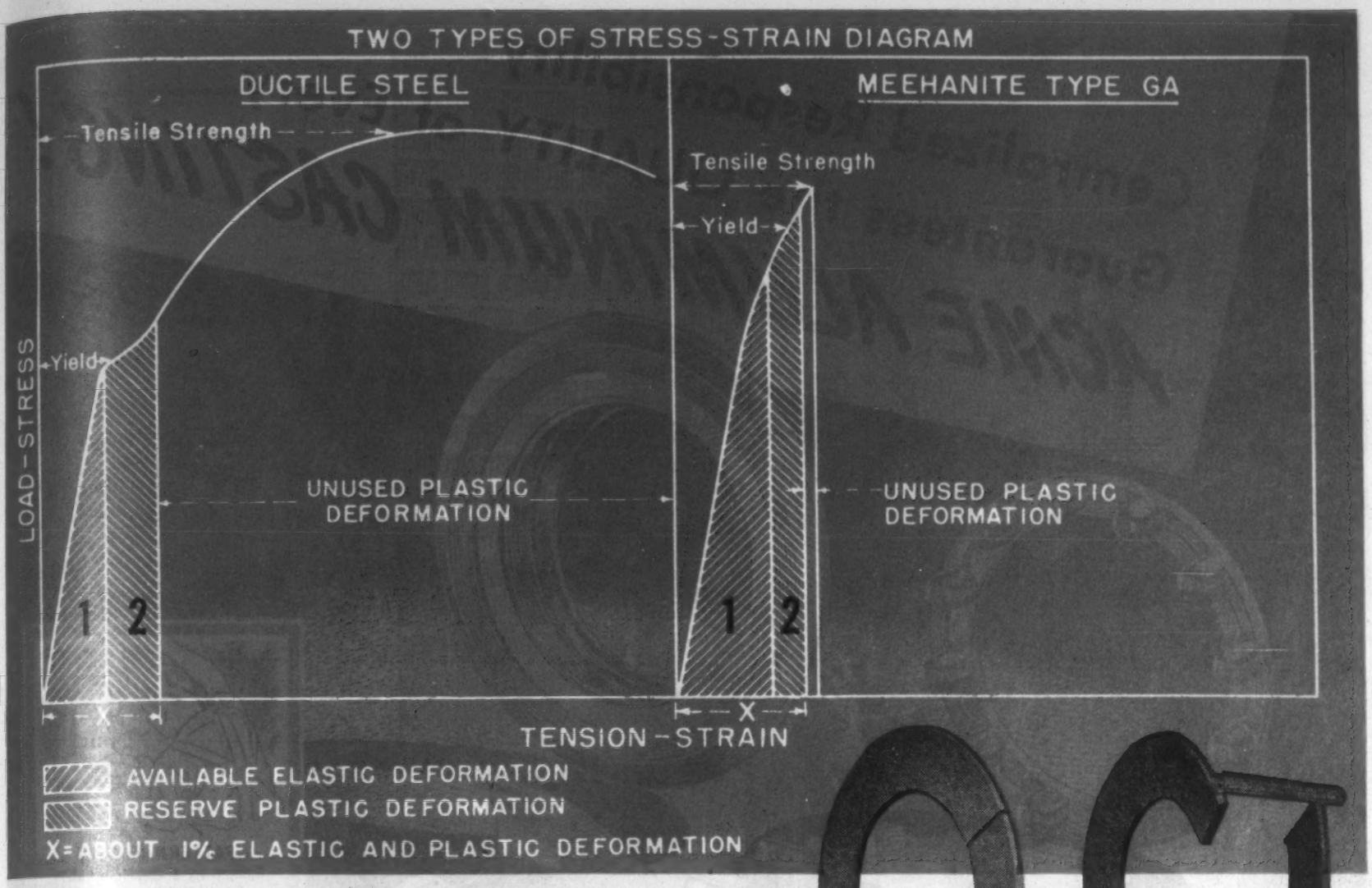
The above data and accompanying diagram are from Westinghouse. It is well to survey other fields briefly. Gas turbine powered locomotives are used successfully by the Swiss. In the marine field, it is a prospective prime mover in the very near future. Trucks and busses, with their much smaller power requirements, will still depend on the reciprocating engine.

Uncle Sam Uses His Head

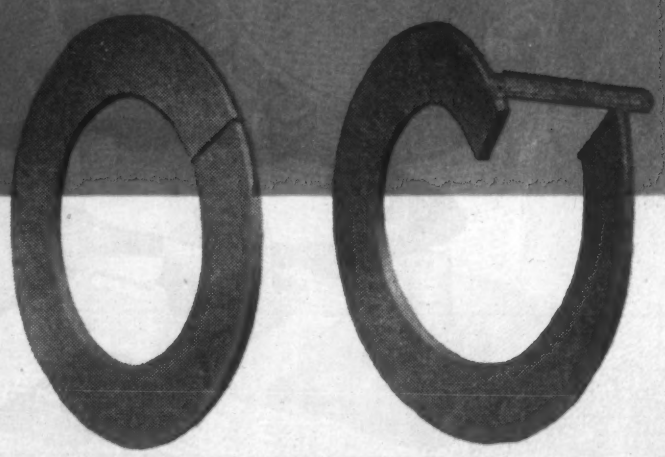
Production of metal insect screen cloth needed by the military and civilians will be increased by 20% by the use of rectangular instead of square mesh. The new screening is of 18 by 14 mesh as against 18 by 18 and 16 by 16 formerly used. Exhaustive tests have shown that mosquitoes and other bugs can negotiate the new screening no more easily than the old. The saving in the metal alone is 11%, or 20%, including labor.

Gasoline drums for the military's use in the Far East are now being manufactured in a forward area of the India-Burma theatre. Steel is shipped from the United States in sheet form, thus conserving valuable shipping space. More than 100 tons are shipped daily from Calcutta to the new drum plant.

American soldiers are using a new type of land mine that foils detection by the enemy. They are entirely non-metallic and cannot be located by conventional enemy mine detectors. They are made of porcelain or glass parts sealed to a flexible synthetic rubber bellows, all watertight. Pressure on the top of the mines compresses the bellows and explodes the mines. The sealing is done with Goodyear's "Pliobond," which substitutes for the original cement made of natural rubber.



MEEHANITE CASTINGS ARE TOUGH!



This 1" thick section was cut from a heavy Meehanite casting. It was possible to split the piece as shown 3½" before fracture.

FACTS, FIGURES, DATA, AVAILABLE AND RELIABLE FOR THE USERS OF MEEHANITE CASTINGS

In engineering design the ultimate breaking strength of any material is rarely used. Designers require safety in service, not failure. There is a considerable gap between the yield point and the ultimate strength.

The stress-strain diagrams plotted from a tensile test of mild steel and Type GA Meehanite appear as shown above.

Steel shows both a higher ultimate strength and elongation value than Meehanite. The important point, however, is how much of these values can be used in unit design.

The diagrams reveal three distinct areas:

1. *Stress absorbed during elastic deformation. This has relation to the Modulus and Yield strength.*
2. *Stress absorbed during elastic and plastic deformation which has some relation to the reserve of plasticity available against sudden fracture.*
3. *Plastic changes recording deformation during failure.*

Areas 1. and 2. illustrate in a general way, the relative capacity of both materials to absorb working stress in service up to approximately 1% plastic deformation, which is as much as any normal engineering construction can endure.

They show that to this extent Meehanite, despite its lower ductility, does have as large an area for plastic adjustment to distribution of the load as the so-called ductile metals.

This explains why Meehanite is finding wider engineering applications in structures normally calling for high elongation and reduction of area values.

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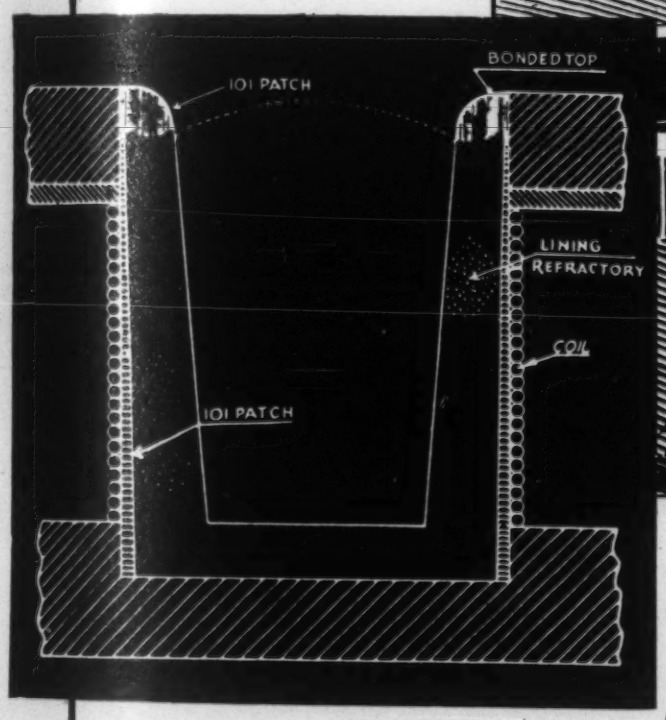

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3. **Excellent profile appearance**
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Yield strength, lb per sq in....	53,000–57,000	47,000–52,000
Per cent elong. 2 in.....	27.0–32.0	32.0–38.0
Per cent reduction of area.....	54.0–62.0	60.0–66.0

Impact resistance ft-lb Izod	50–70
Endurance limit, lb per sq in.	30,000–34,000
Density, grams per cu cm	7.83–7.86
Brinell hardness	150–170

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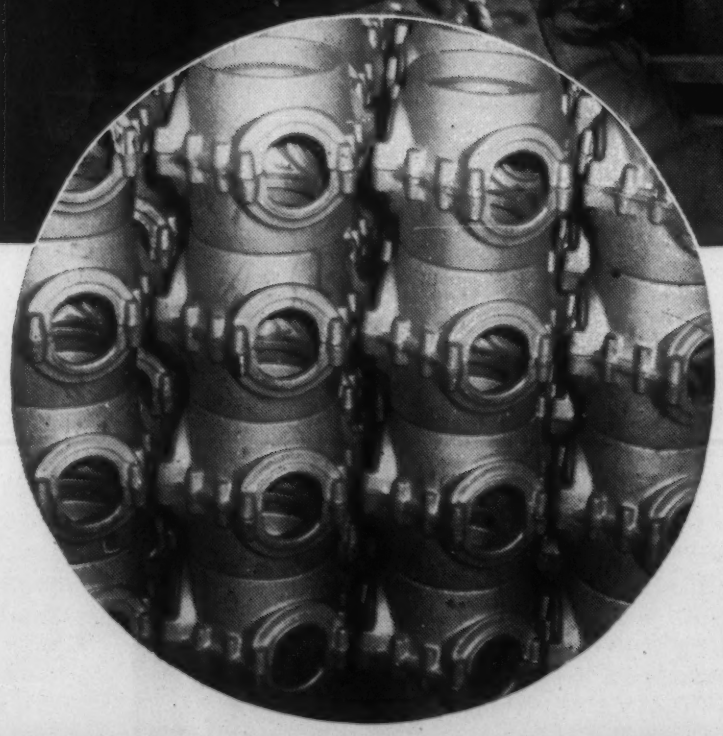

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How Stainless Steel is Machined at Roebling's

Correct Control Brings Results in Quantity Production of Aircraft Cable Fittings—Tolerances of .0005" Maintained—Importance of Power, Speed, Feed, Tool Angles, Coolants

A Report on the Details of Operations in the Trenton, N. J. plant of John A. Roebling's Sons Company

The machining of stainless steel is not difficult, but different, as compared to ordinary screw stock. The main difference is that you cannot be careless with stainless. Everything along the stainless production line must be kept under exact control. This sums up the experiences of Ray Brodowski, Foreman of Dept. 26, John A. Roebling's Sons Company, Trenton, New Jersey.

The job must be done with unusual accuracy. All the strength that can be had must be crowded into very thin cross sections with widely differing dimensions. This calls for fine machining with a capital "F"; the job would be tough to handle no matter what the material.

The finished parts must be swaged onto steel cables. This requires the selenium grade of Rustless 18-8 FM, Type 303, since the grades containing other free machining agents have been found unsuited for this severe operation.

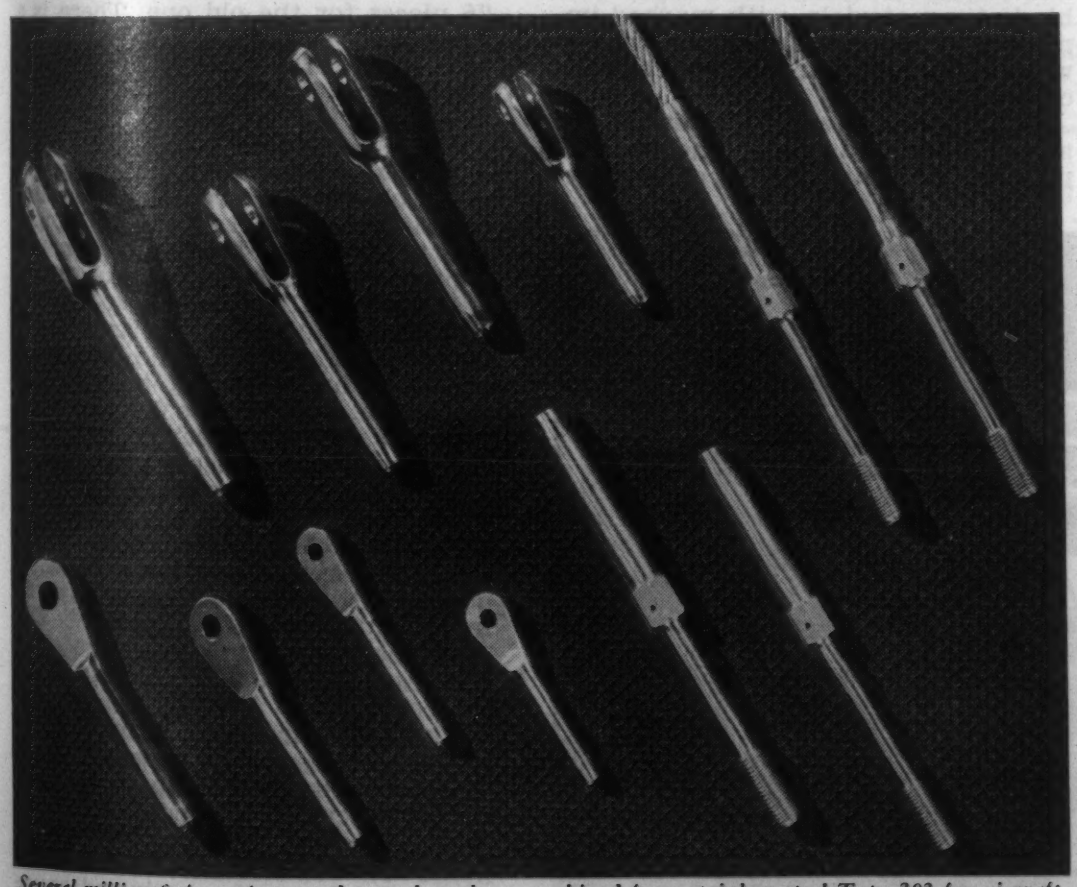
In the face of these problems, Roebling's is making these parts quite successfully. A few simple methods are followed; methods which would make for accuracy on any material but are especially applicable to stainless.

The first essential is absolutely uniform steel; steel that always behaves properly in the machines. A large proportion of the stainless used by Roebling's for this job comes from the specialist in stainless steels, the Rustless Iron and Steel Corporation.

An overall control principle which applies alike to every operation is: "Do not be gentle with stainless". Whether they are severing the metal by cutting or compacting it by swaging, Roebling's men always apply plenty of power.

The reason for this is that this grade of stainless tends to work harden ahead of the tool. Each successive "bite" therefore must get beneath the work hardening left by its predecessor. Cutting tools should have heavy feeds; otherwise too much of the chip area will be of work hardened steel and the tools will burn up. Swaging tools must have force enough so they are compacting metal beneath the surface layer which has been hardened by previous impacts.

After the terminals are swaged to steel cables, the entire assembly is proof tested to 60% of its minimum breaking strength. They must stand this test with extremely limited elongation. Variations in the strengths of the stainless steel fittings, then, would mean scrapping not only of these completely finished parts but also (in many cases) of the cables as well. In fact, the high and uniform strength of stainless coupled with excellent ductility is one of the principal reasons for using it on these cable ends.



Several million fittings of assorted types have been machined from stainless steel Type 303 for aircraft control cable terminals by various manufacturers. Corrosion resistance, high strength, ductility for cold swaging, combined with machinability, are the major reasons for the use of this type of stainless.

On the Automatics

The sizes of stainless steel bar stock used as raw materials, run from 13/16" down to 7/32" round, and 3/16" to 3/8" hex.

First operations usually are performed on automatic screw machines, with shank diameters machined to tolerances of plus .000" minus .003", lengths of cuts held to plus .000" minus .020".

The rake and clearance angles of tools are highly important, since the first rule of stainless machining is to keep all tools perfectly ground and perfectly set.

Roebling's has found the recommended tool angles on page 7 of the Rustless book, *"Shop Notes on the Machining of Stainless Steel"* quite satisfactory. (That book, which was one of the most understandable and useful ones in the shop, has just been replaced by a new and much more comprehensive Rustless booklet, *"Machining Stainless Steels."*)

No chip breaker is used unless the chips produced without one are bothersome or damaging to machine operation. The reason is, the finish is smoother if the chips are not broken. In general, no chip breaker is needed for any cut of less than 1/64" depth, but from 1/64" to the deepest cut of .225" the chips must be broken.

Turning feeds range from .0015" to .0047", with speeds from 70 to 94 surface feet a minute (SFM). The heavier the feed, the less the troubles from work hardening. But if tools show signs of over-heating, the chip pressures must be reduced or other factors modified. Usually the speed is reduced and the feed kept constant.

(ADVERTISEMENT)

Reducing the feed is the surest way to get into work hardening troubles, and these will burn up the tools in short order.

Drilling is one of the difficult operations. The holes, after centerless grinding the shank, must be concentric and parallel with the O.D. to plus or minus .005". And those holes are small and deep.

Spot drilling and inside chamfering are performed at one position, then the hole is drilled to about ⅓ of its final depth at a second position. The final drilling is done on drill presses, a recommended practice which increases automatic screw machine output.

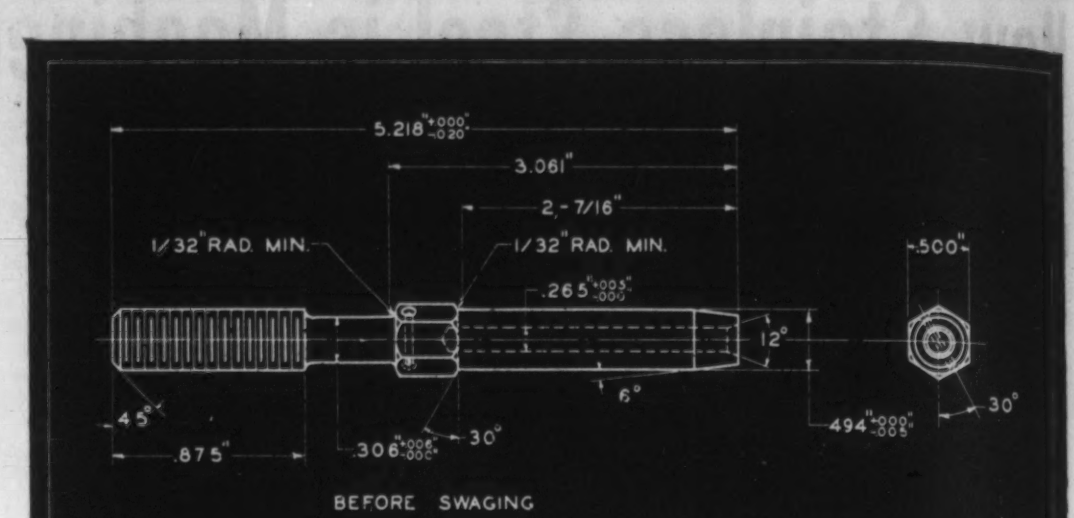
It is important that all drilling on the automatic be done at positions where very little side pressure is being exerted by other tools upon the stock. Such side pressure can make differences as great as .002" and even .003" in the concentricity of the hole.

Operators inspect every piece that comes from the automatics. At the slightest sign that a machine is "crowding the limits" or otherwise threatening to give trouble, the set up man is sent for. Continual inspection is one sure way to avoid trouble. Precision machining of stainless must be kept under complete control.

Centerless Grinding

Many of the precautions taken to insure dimensional accuracy and perfect finish would be as necessary with other steels as with stainless. Some of the centerless grinding precautions are among them.

Centerless grinding usually follows the automatic screw machine operations. The purposes of the grinding are (1) to remove all scratches and tool marks, and (2) accuracy, with sections which are to be threaded being held to plus or minus .0005". To make sure that the grinding gets below all tool marks and leaves a flawless finish, from .005" to .008" of stock is removed.



This terminal is machined from stainless steel, Type 303, at high-production rates. See accompanying text for details of machining operations.

It is important to keep all contaminants out of the grinding coolant. Therefore all work is cleaned and degreased before being taken to the grinder. Any straight cutting oil from the automatics carried to the grinder with the work would change the viscosity of the grinding coolant and might cause the entrainment of steel chips or of abrasive particles with consequent scratching of the work.

The coolant is mixed 20-1 with water, and a special paste is added to increase the lubricity.

Lubricity is needed to make sure that the work is not scratched by the work rest blades. For further protection against scratching, the blades are tipped with an aluminum bronze which is an excellent bearing material; it has very low coefficient of friction when lubricated by the coolant. This bronze has displaced harder and longer lived blade tip materials, with marked improvement in work finish. When badly worn it is restored by a simple welding operation.

The blades are carefully set to a 20° angle. This angle holds the work in position with minimum bearing pressure between work and blades, with consequent minimum scratching if any abrasive gets between the work and the bronze. And at the same time, it permits the coolant to flow off freely, with no surfaces which will entrap loose particles and keep them in position to scratch the work.

Grinding wheels must be dressed often enough to keep up the production rate of the machine and preserve perfect finish on the work. All the grinding must come up to shoulders which bear on one side of the wheel only. The first wheels used, refused to stand the stress of grinding against hex shoulders. Therefore a wheel was adopted which has a 3/16" hard side; the main body of the wheel being 80 N5BE (Norton Company) and the hard side 80 P5BE.

This wheel needs dressing only after every 200 pieces or so, as compared to 75 pieces for the old one. There is a worthwhile gain in daily output as well as in wheel life.

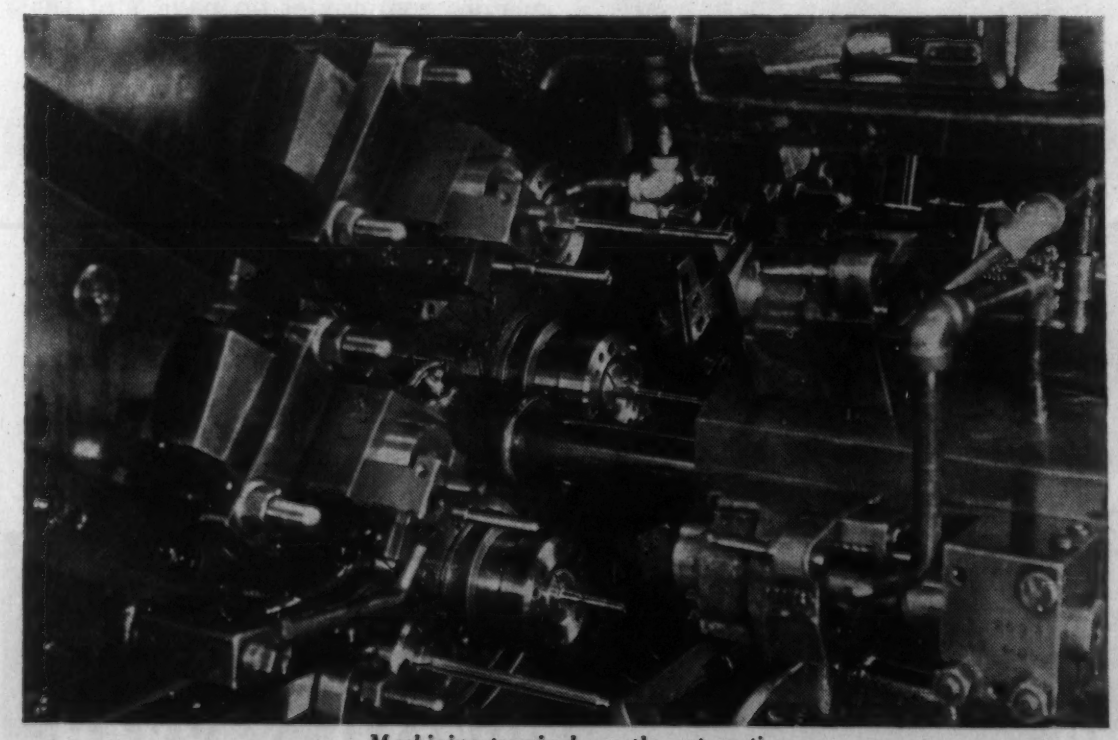
On the Drill Presses

Drilling of the deep holes present two problems: (1) to get the holes concentric and parallel with the O.D., and (2) to complete them to their full depth. Starting the holes accurately is best done on the automatics. But finishing them to full depths requires repeated raising of the drill points from the work and lowering them again, each such cycle being called a "dive". And this diving or pecking motion is most easily accomplished as a secondary operation on a drill press.

Roebling's has found that some holes should be drilled on manually controlled presses, while others can be done on the Leland Gifford Hydromatic Automatic Drill presses. The difference is in the size of the drill. Drills smaller than No. 17 need manual control.

The operator of the manual press must have a sensitive touch. Only by "feel" can he tell when to lift the drill for another dive. Furthermore, he must be careful to raise the drill as abruptly as possible so the drill point does not idle on the work and cause work hardening.

Automatic controls, by contrast, are



Machining terminals on the automatics

set at 3/16" per dive. They lift the drills quickly enough to prevent any troublesome amounts of work hardening.

Crankshaft drills were used originally, but it was found that the Hi-Spiral ones were equally rapid in action and could be re-ground much more quickly.

Grinding of the drill points is important. First of all, the grinding wheel must be diamond dressed to the highest possible accuracy so the point itself is fully accurate. After that, the drill point must be ground to a far more obtuse angle than is used for carbon steel. 140° is about right. (The standard angle is 118°.)

As in all stainless machining, Roebling's finds that it is better to cut down the SFM than the feed if drilling troubles are encountered. Feeds range from .002" to .004", SFM from 40 to 50. Chips should be heavy enough to work up the flutes readily. Light chips tend to get between the sides of the drill and the hole, causing rapid wear of drills as well as spoiled work.

Because of the high cutting temperatures at the drill points, soluble cutting oil has displaced the "straight" kind on this work. The soluble oil also tends to preserve the clearances on the drills longer, and to remove the chips better.

With such accurate control methods, Roebling's is doing some highly accurate drilling. One example is two .272 Dia. parallel holes drilled simultaneously only .024" apart in 13/16" stainless stock.

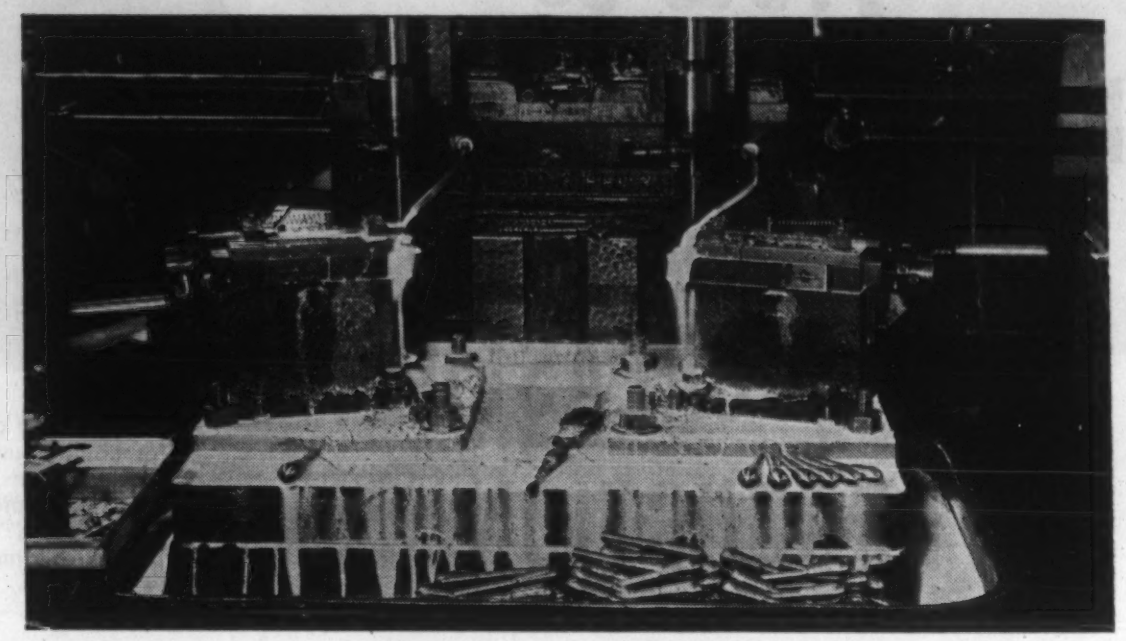
Thread Rolling

The thread rolling is the last major operation, and it is the one which is most easily spoiled by any variations in the stock. Roebling's, of course, cannot do anything more about the steel itself than to make sure that it comes from a steel plant which is rigid about living up to specifications. But Roebling's can—and does—be careful that the sections to be threaded are well within their plus or minus .0005" tolerances. This initial accuracy would be necessary with any metal to roll threads to a class 3 fit, but with a tough metal like stainless it also helps the rolling operation.

Thread rolling, like all other operations on stainless, requires plenty of force. Thus, even on these small parts the No. 20 Waterbury Farrel Machine is not heavy enough for some of the work and the No. 30 does much better.

Speeds must be controlled. A Reeves variable speed drive is attached to each thread rolling machine, and speeds are variable within a wide range. The larger the thread the faster can be the machine speed. Straight cutting oil is used as a die lubricant.

Inspection is close. Work specifications call for a number 3 fit, which means no taper, full size with proper lead and pitch. A comparator is within easy reach of each machine, and every tenth piece is checked by it.



Deep-drilling on the pecker Drills

General Working

Standard grade of high-speed tool steels are used, the only requirement being that the tool must be Rockwell C65 or harder. But this requirement must be observed; softer high-speed steels had only one-third the tool life of the C65 ones.

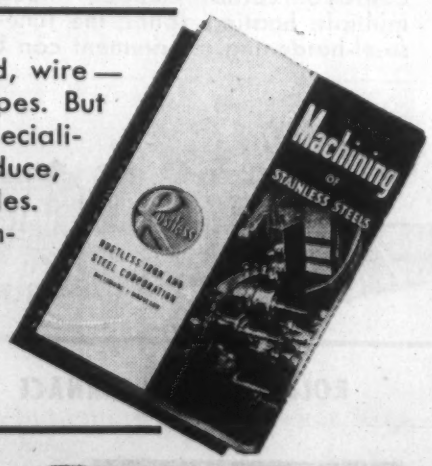
Cutting oil for every operation must be high in lubricity and have no tendency to gum or stick the working parts of machines. All new cutting oil is sterilized before being fed to the machines. Keeping the cutting oil clean and free of entrained metal particles is important. At least 50% of the oil used in the automatics is cleaned in a Barret oil reclaiming and cleaning system every day. Each machine is completely cleaned out at least once for every twenty days of continuous operation. The results include higher production rates, fewer spoiled parts, and almost no dermatitis among operators.

The cutting oil is fed at the maximum pressure which the machine pumps can deliver. It must be carefully guided so the full force of the stream strikes at the spots where the chips impinge upon the tools.

Methods like these keep the stainless production line flowing smoothly. They are helped by the fact that any carelessness quickly shows up in damaged work, and therefore the carelessness cannot be hidden. The machining of stainless steel, in short, is a job for the man who knows how to get his machines under control and keep them that way.

The End

Rustless produces stainless steels only, in bar, rod, wire—rounds, squares, hexagons, flats and special shapes. But we offer you much more than that. By intensive specialization we have learned not only how to produce, but how to select and fabricate the various grades. For example—our machining engineers have completely revised our popular booklet, "Shop Notes on the Machining of Stainless Steels." Copies of the new booklet, mentioned in this advertisement, will be sent free on application.



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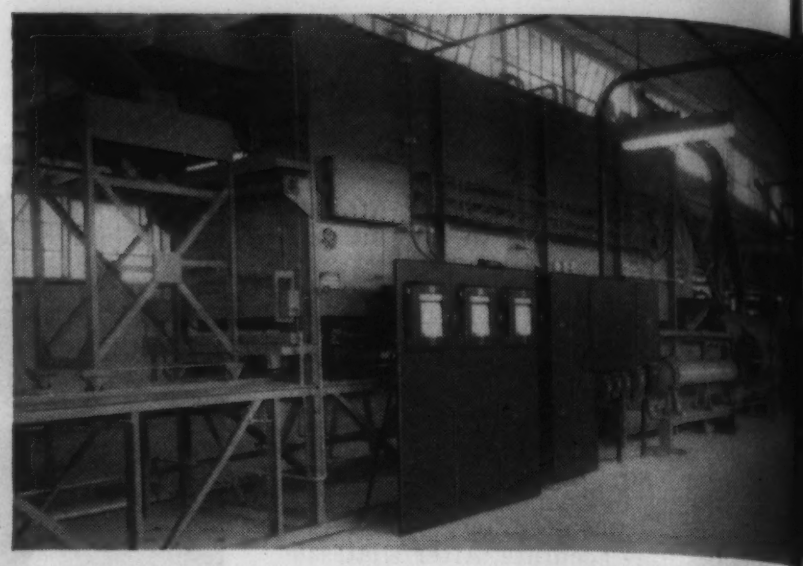
Rustless

Producing STAINLESS STEELS *Exclusively*

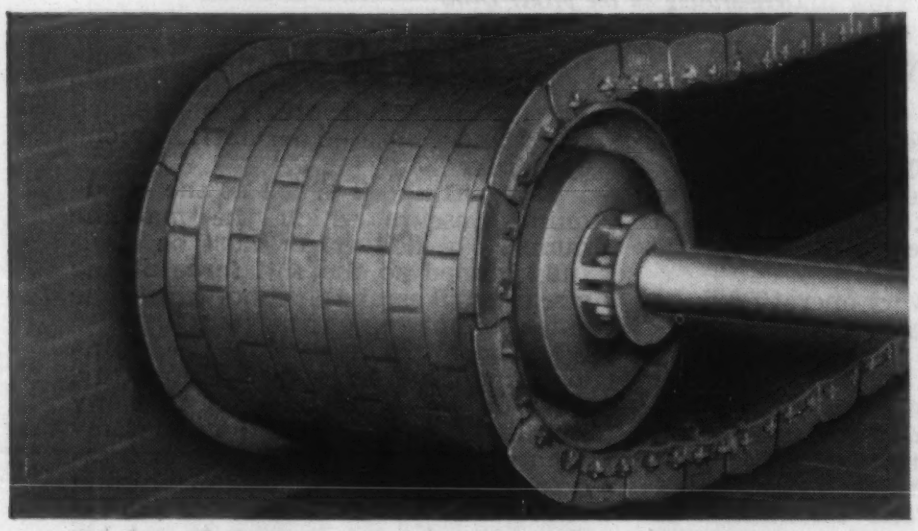
RUSTLESS IRON AND STEEL CORPORATION

BALTIMORE 13, MARYLAND

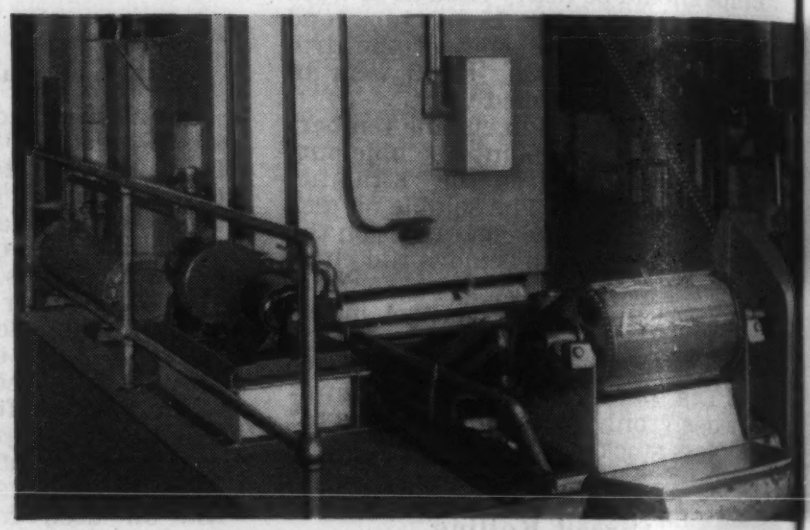
How to
HARDEN STEEL PARTS
in a CONTINUOUS FLOW
for INCREASED PRODUCTION



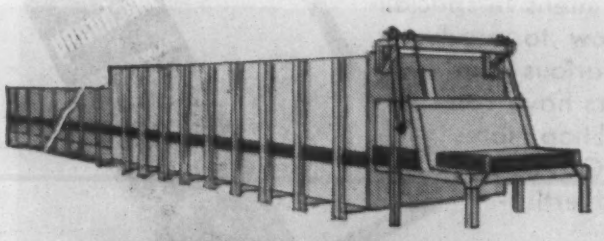
The G-E belt conveyor electric furnace is specially designed for continuous scale-free hardening of bolts, nuts, springs, machine parts, tools, or other small steel products. Representing a typical application, the furnace above is used for hardening a continuous flow of machine-gun links in a protective atmosphere.



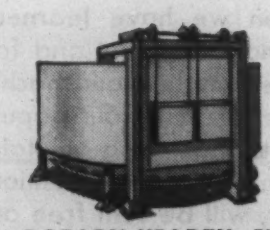
The conveyor belt is entirely enclosed in the heating chamber to permit a non-decarburizing atmosphere to be maintained at all times. By adjusting the speed at which the conveyor carries charges through temperature-controlled, multiple heating zones, the time-temperature cycle for any steel-hardening requirement can be maintained.



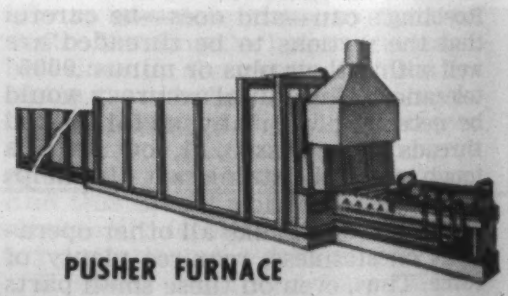
After being uniformly heated, the charge is dropped through a sealed chute, into an oil-quench tank. In a typical installation, a high-velocity flow of quenching medium quickly cools the hot material as it falls from the furnace. A second conveyor within the quench tank automatically discharges the hardened parts from the quench.



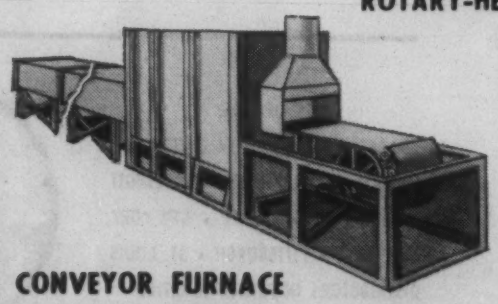
ROLLER-HEARTH FURNACE



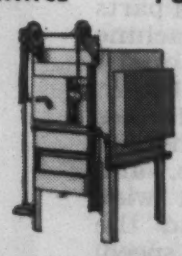
ROTARY-HEARTH FURNACE



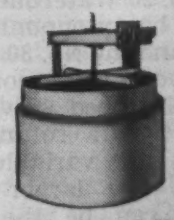
PUSHER FURNACE



CONVEYOR FURNACE



BOX FURNACE

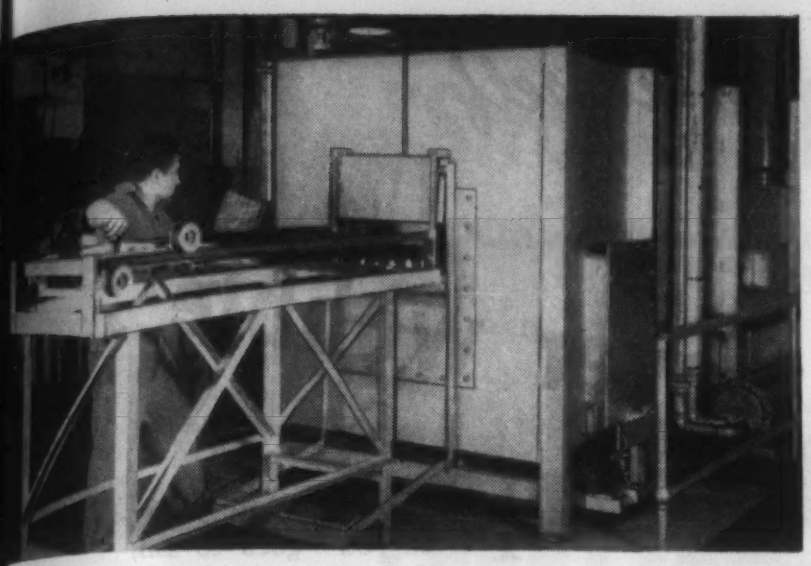


PIT FURNACE

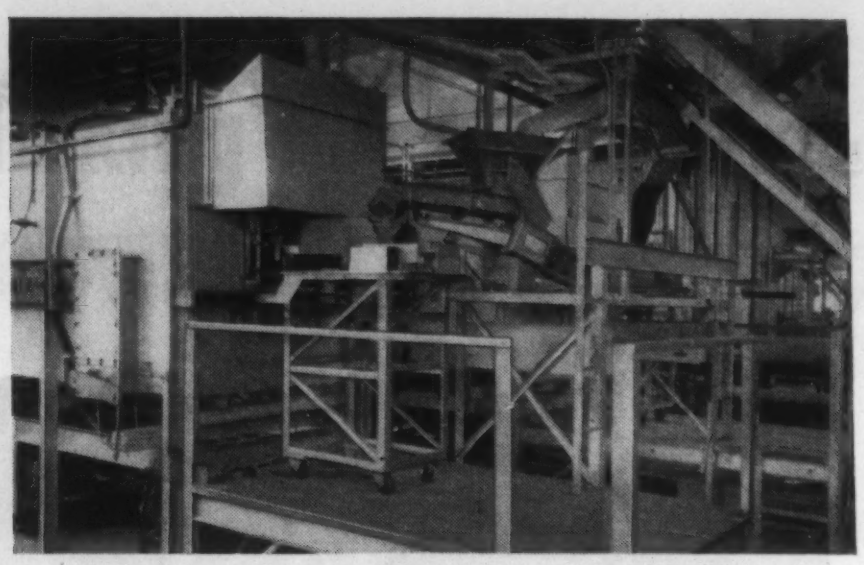
GE ELECTRIC FURNACES

FOR PRACTICALLY EVERY INDUSTRIAL NEED

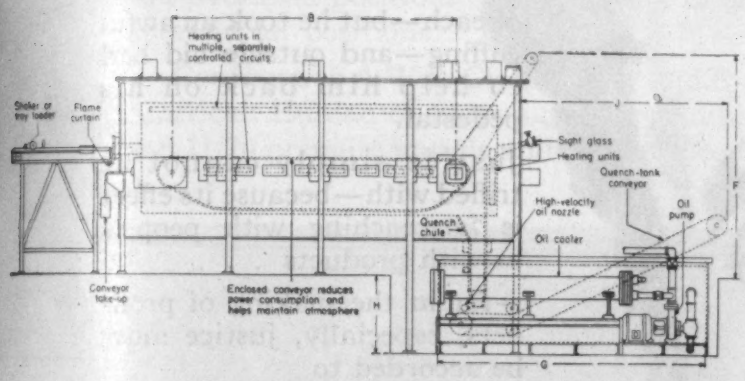
BACKED BY A NATIONWIDE ENGINEERING SERVICE



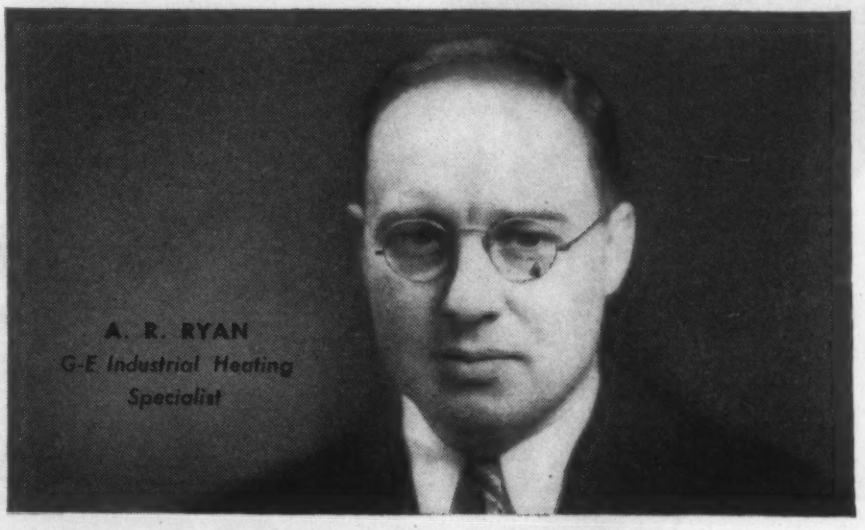
Depending upon the type of product to be hardened, one of two types of loaders may be employed. Designed for general use, the tray loader is specifically recommended for loading certain types of parts. It is manually operated and assures accurate spacing of charges placed upon the conveyor belt.



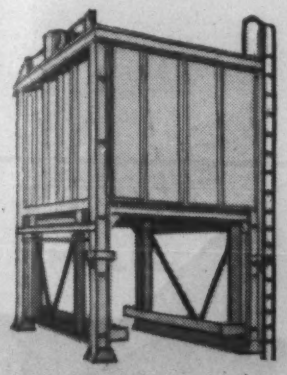
The automatic motor-operated shaker loader is designed to handle large quantities of small parts, such as bolts, nuts, and springs. When parts to be hardened are fed into the shaker loader in a constant volume, the device automatically loads the furnace conveyor at a similar rate.



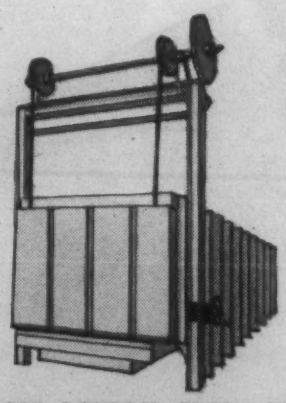
In this schematic diagram of a typical G-E belt-conveyor electric furnace, note that the entire heat-treating operation is automatic—from the time of loading until the hardened parts are discharged from the quenching medium. If the uniform hardening of numerous small steel parts, *at low cost* is of interest to you—



—get in touch with one of our many industrial-heating specialists, who are in most of the principal cities. He will be glad to study your requirements and to suggest the most efficient means of meeting them. His recommendations are based upon years of practical experience. For details—



ELEVATOR FURNACE



CAR-BOTTOM FURNACE

- - - contact the nearest G-E office, or mail the coupon below:

General Electric Company, Sec. 675–114
Schenectady 5, N. Y.

—Please send me your bulletin, "Belt-conveyor Electric Furnaces," GEA-2790A.

—Please send me your bulletin that describes the following other types of furnaces: .....

—Please have a G-E heating specialist call at the earliest opportunity.

NAME .....

COMPANY .....

ADDRESS .....

CITY ..... STATE .....

Buy all the BONDS you can—*and keep all you buy*

GENERAL ELECTRIC

then he said to himself

"Don't ever wobble"

TODAY'S prize "Didn't-I-tell-you" goes to Emperor Haile Selassie for his prewar speech in the late League of Nations . . .

—in which he voiced this prophecy:

"As long as you subordinate justice to peace—you will achieve neither justice nor peace."

[illegible] now has a modified amount of [illegible]each—but he took an awful [illegible]uffing—and outside aid had to help him back on his pedestal.

Justice simply cannot be trifled with—because its effect is far-reaching with peoples as with products . . .

—for in the making of products, especially, justice must be accorded to

(a) the design
(b) the cost
(c) the output
(d) the worker
(e) the stockholder
(f) the user

—otherwise that product gets slapped off its pedestal.

Justice is simply honesty in action—such as—

"Straight Thinking Pays" . . . *he says*

LOOK, EMPEROR, how straight thinking with this new Lincoln Electrode can improve Arc Welding for greater justice to cost, output and quality in many applications:

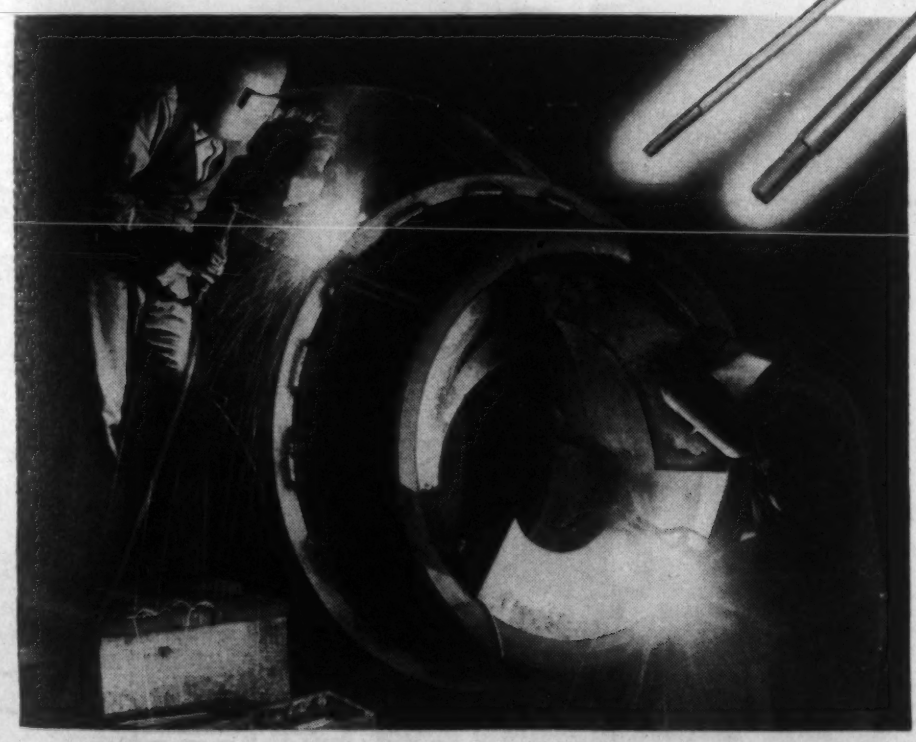
Easy Operation *for Fillet Welds... All Positions*

"FLEETWELD 47"

Lincoln announces a new member of the world-famous Lincoln "Fleetweld" family:

"Fleetweld 47" is a shielded arc electrode for use with A.C. or D.C. Designed primarily for real ease of operation in all positions with excellent appearance and very easy slag removal. (Most welds practically self-cleaning.) Has extremely quiet arc and low spatter loss. Very smooth bead surface and good slag coverage. Operates especially well in flat, horizontal, vertical and overhead positions. Good control of shape of bead in large fillets in all positions.

Conforms to A.W.S. Class E-6012 and E-6013. Approved by American Bureau of Shipping. For welding A.S.M.E. U-69 and U-70 pressure vessels under insurance requirements.



Especially well suited for:

1. Single pass horizontal fillets and single and multiple pass fillets in the vertical and overhead positions.
2. Vertical, horizontal and overhead butts in plates over ½" thick.

PHYSICAL PROPERTIES

(AS WELDED): Tensile strength—68,000 to 80,000 lbs. per sq. in.
Yield point—55,000 to 62,000 lbs. per sq. in.
Elongation in 2 inches—18% to 25%.
Impact resistance—25 to 50 ft. lbs. Izod.

(STRESS RELIEVED):
Tensile strength—64,000 to 79,000 per sq. in.
Yield point—48,000 to 60,000 lbs. per sq. in.
Elongation in 2 inches—24% to 30%.

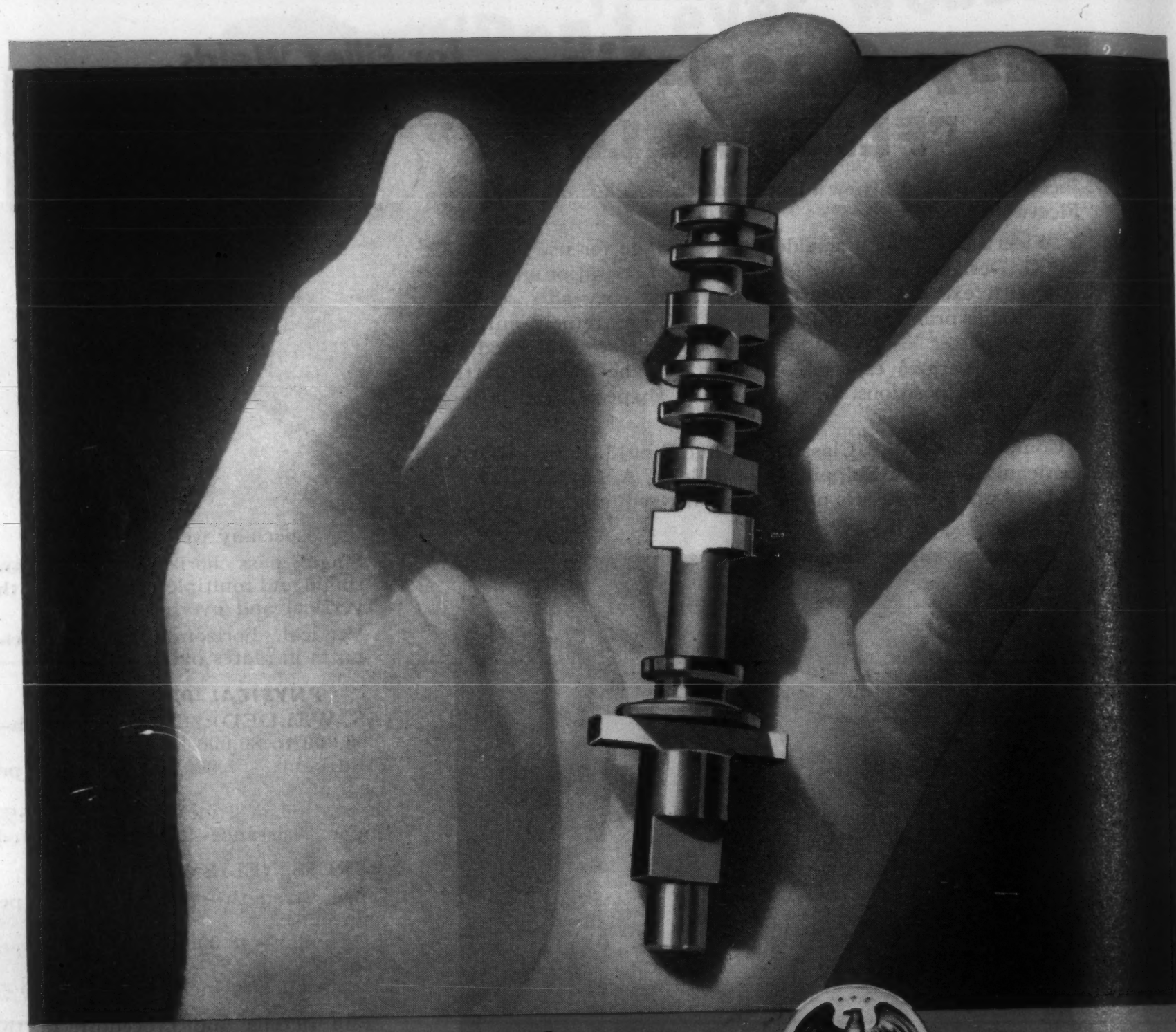
Full details and procedure in the "Weldirectory," Bul. 402, free on request.

THE LINCOLN ELECTRIC COMPANY • DEPT. M-1 • CLEVELAND 1, OHIO

America's greatest natural **recourse**

ARC WELDING

A Little Steel Part that Tells a Big Story



Republic

REPUBLIC STEEL — PRODUCTION FOR VICTORY

US

UNION COLD DRAWN STEELS

Reg. U. S. Pat. Off.

Free-Machining Bessemer, Open-Hearth and Electric Furnace Steels

•

Union Cold Drawn Special Sections

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Union Cold Drawn and Ground Rounds; Turned and Polished Rounds; and Turned, Ground and Polished Rounds (Union Precision Shafting).

# of MACHINABILITY

Look at the little camshaft on the opposite page. It was made from UNION SUPERCUT (A.I.S.I. B-1113)—fabricated on automatic and hand screw machines, then hardened at wearing surfaces by selective carburizing.

But the important part of the story is the amount of machining necessary. The weight of the finished camshaft—only ⅛ of the steel bar from which it was made—indicates that it was necessary to machine away ⅝ of the original bar to produce this complicated little part.

That's why UNION SUPERCUT was used—because it is "tops" among free-machining steels.

Long ago, Union Drawn recognized the vital importance of *MACHINABILITY* in the production of steel parts. Metallurgists directed the major share of their laboratory and plant research toward better machinability. Engineers cut up tons of steel on an "automatic" and spent days and weeks in customers' plants studying the performance of various steels.

The results: A steadily increasing ability on the part of Republic Union Cold Drawn Steels to machine to a fine, smooth surface at higher speeds and heavier feeds.

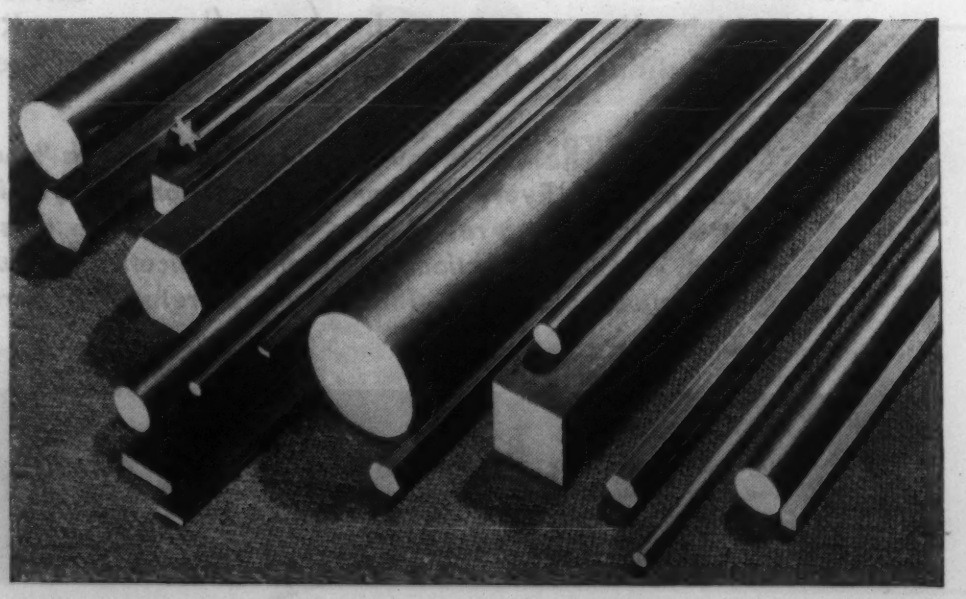
A marked decrease in abrasive elements in the steel—providing longer tool life, more parts per dollar of tool investment, fewer grindings of tools, greater efficiency of operation, more output.

And all these advantages without sacrifice of physical and heat-treating properties.

This little camshaft is only one of thousands of different parts which have demonstrated the cost-saving, production-increasing machinability of Republic Union Cold Drawn Steels. The steel parts YOU make probably will do the same if you specify these steels. Republic metallurgists are ready to work with you to obtain maximum results in machining and heat treating.

REPUBLIC STEEL CORPORATION
Union Drawn Steel Division • Massillon, Ohio
GENERAL OFFICES • • CLEVELAND 1, OHIO
Export Department: Chrysler Building, New York 17, N. Y.

To further increase machinability, and to assure uniform hardness and physical properties, Union Drawn has greatly increased capacity in all plants for *furnace treated* cold drawn steels—annealed, normalized, spheroidized, stress relieved and otherwise heat treated.



TROUBLE-FREE PERFORMANCE

THE WARP THREADS of a power loom pass through eyes of slender heddles, raised by a rod running through a hole at the heddle end. Severe strains often cause ends to snap off. Removing all heddles to make replacements would waste endless time so repair heddles are used. These have a leaf spring hook which allows them to be snapped on the rod without disturbing other heddles.

Many materials were tried for the repair hooks. Some rusted, coloring the cloth. Some lost their "spring" or became brittle when welded. Some had to be dipped or plated. Easy-to-form, corrosion resistant, weldable *nickel silver* by Riverside filled the bill. *Nickel Silver, Phosphor Bronze and Beryllium Copper* are Riverside alloys in your future. On which of them shall we send you a booklet?

INSIDE RIVERSIDE—*If you are bored by the words "personal service", perhaps we can revive your interest. Every order or communication from you is examined the morning of its arrival at Riverside by a round table of top responsible persons—from shop, laboratory, management. All knotty questions concerning application, production and delivery of Riverside Alloys are untied on the spot. This is our interpretation of personal service.*

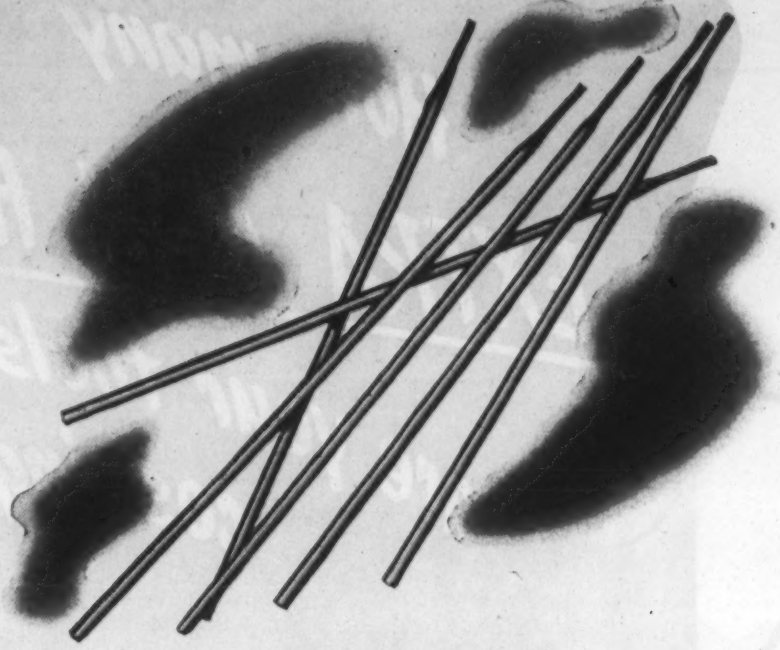
RIVERSIDE

RIVERSIDE METAL COMPANY

NEW YORK CHICAGO RIVERSIDE • NEW JERSEY HARTFORD CLEVELAND

RIVERSIDE PHOSPHOR BRONZE ALLOYS — Copper-tin alloys to which phosphorus is added. Made in variety of wrought and malleable alloys; special leaded mixtures; in non-malleable cast and turned rods for bearings and bushings.

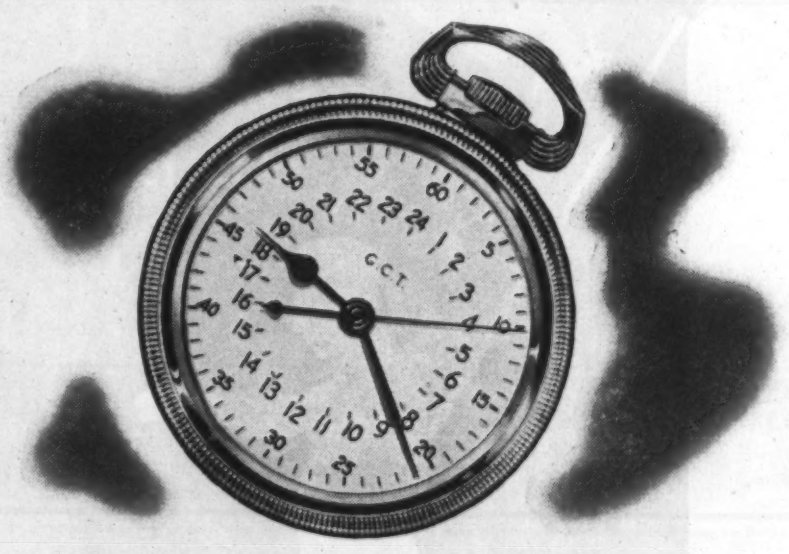
PROPERTIES—Wide range of tensile strengths and hardnesses. In general, phosphor bronze is a good electrical conductor, non-magnetic, and has a low coefficient of friction. It is easy to machine, can be welded by carbon or metal arc (there's a special alloy for flame welding), can be brazed or soldered. Easy to punch, draw, stamp, or spin. Phosphor bronze is rustless and resistant to corrosion, fatigue and wear. Supplied in sheets, strips, wire, rods, circles, bars, blanks or ingots.



Typical use: Welding Rods

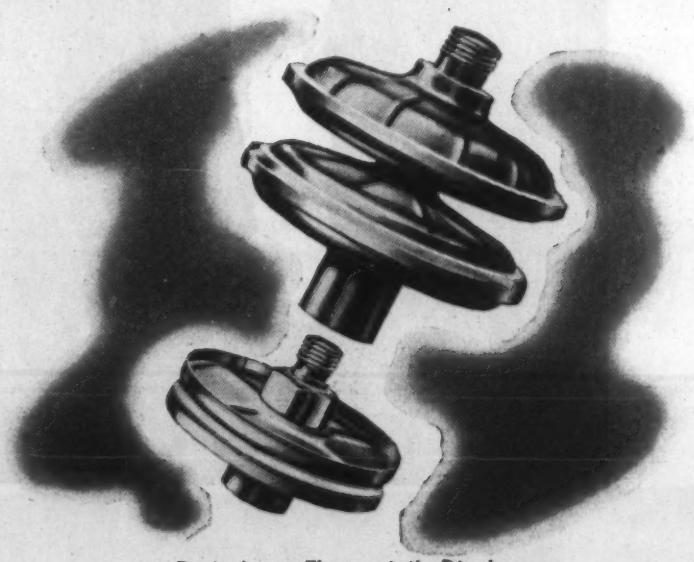
RIVERSIDE NICKEL SILVER ALLOYS — A combination of copper, nickel and zinc in various proportions. Made in variety of alloys, tempers, anneals; and in free-cutting alloys.

PROPERTIES—Vary according to alloys. Tensile strengths up to 160,000 p.s.i., elongations up to 50%. Nickel silver is valued electrically for its specific resistance, and physically because of its clear-through silvery white appearance. In general, it is tough, resistant to wear, fatigue, and corrosion. Easy to machine in any manner, weldable by *all* methods, can be brazed or soldered and is extremely workable. Readily formed, bent, drawn, stamped, punched, embossed or spun. Supplied in sheets, strips, wire, rods, circles, bars, blanks and ingots.



Typical uses: Watch Case and Movement Components

RIVERSIDE BERYLLIUM COPPER — an alloy with an unusual combination of properties — Unusually high strength. Excellent hardness, wear resistance and corrosion resistance. High thermal conductivity, good electrical conductivity. Easy to braze, solder, punch, draw or stamp. Can be cold worked. Outstanding for hot working qualities. Can be easily hot forged or hot pressed between 1050° and 1425°F., and heat hardened to achieve strengths rare to non-ferrous metals and alloys. Great resistance to fatigue under action, which is pronounced at high temperatures where other non-ferrous materials might fail. Negligible creep or hysterisis. Non-magnetic qualities. Supplied in sheets, strips, wire, rods, bars and blanks, usually, semi-hard, cold worked for fabrication and heat treatment.



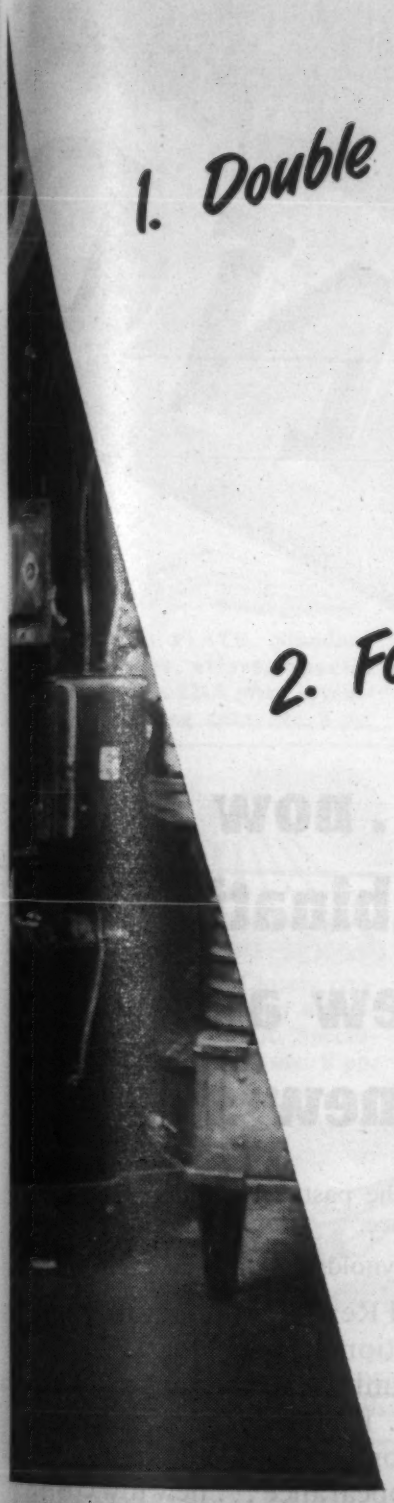
Typical use: Thermostatic Diaphragms

Also special alloys of copper, zinc and tin for specific purposes

PHOSPHOR BRONZE
NICKEL SILVER
BERYLLIUM COPPER

THE CARPENTER STEEL COMPANY • 135 W. Bern St., Reading, Pa.

The Standard Tool Steels of Industry



Here's How to Find Out...

Men stand idle at machines every time a tool is reground or replaced. Time is wasted in the tool room and in heat treating. But now there is a way to stop the costly loss from tools that wear too rapidly or fail prematurely. Even in plants where everyone is satisfied with tool life, the Carpenter *job analysis plan* has stopped the hidden loss of man-hours, tool steel and money. Put these three easy steps to work now. Then watch costs go down and output rise.

1. Double Check Each Job at the Start!

In hundreds of plants Tool Engineers are using the Carpenter Matched Set Method to get tools that stay on the job longer. And it works! This method is a *tried and proved* way to save man-hours at machines, in the tool room and in heat treating. In easy steps it shows which tool steel will give best results on each job. Find out how it can help you gauge tool performance before tools are made. Drop us a note on your company letterhead and ask for the Carpenter "Matched Tool Steel Manual". It is a 167-page book (Free in the U. S. A.) that will give you down-to-earth answers to your tooling problems.

2. Follow Up With Heat Treating "Know How!"

No one has to tell you how important heat treating is in getting 100% performance from tools. And here is your insurance that proper heat treatment will back up your work in designing and making tools. The Carpenter Heat Treating Guide is a handy slide chart that puts complete, correct information at your fingertips. It gives forging and normalizing heats, annealing and hardening treatments, recommended drawing ranges for all the Matched Tool Steels. Plus tips on quenching, drawing and furnace atmospheres. Ask for your free Heat Treating Guide. You can use it to get tools that reduce down time, save man-hours and cut costs.

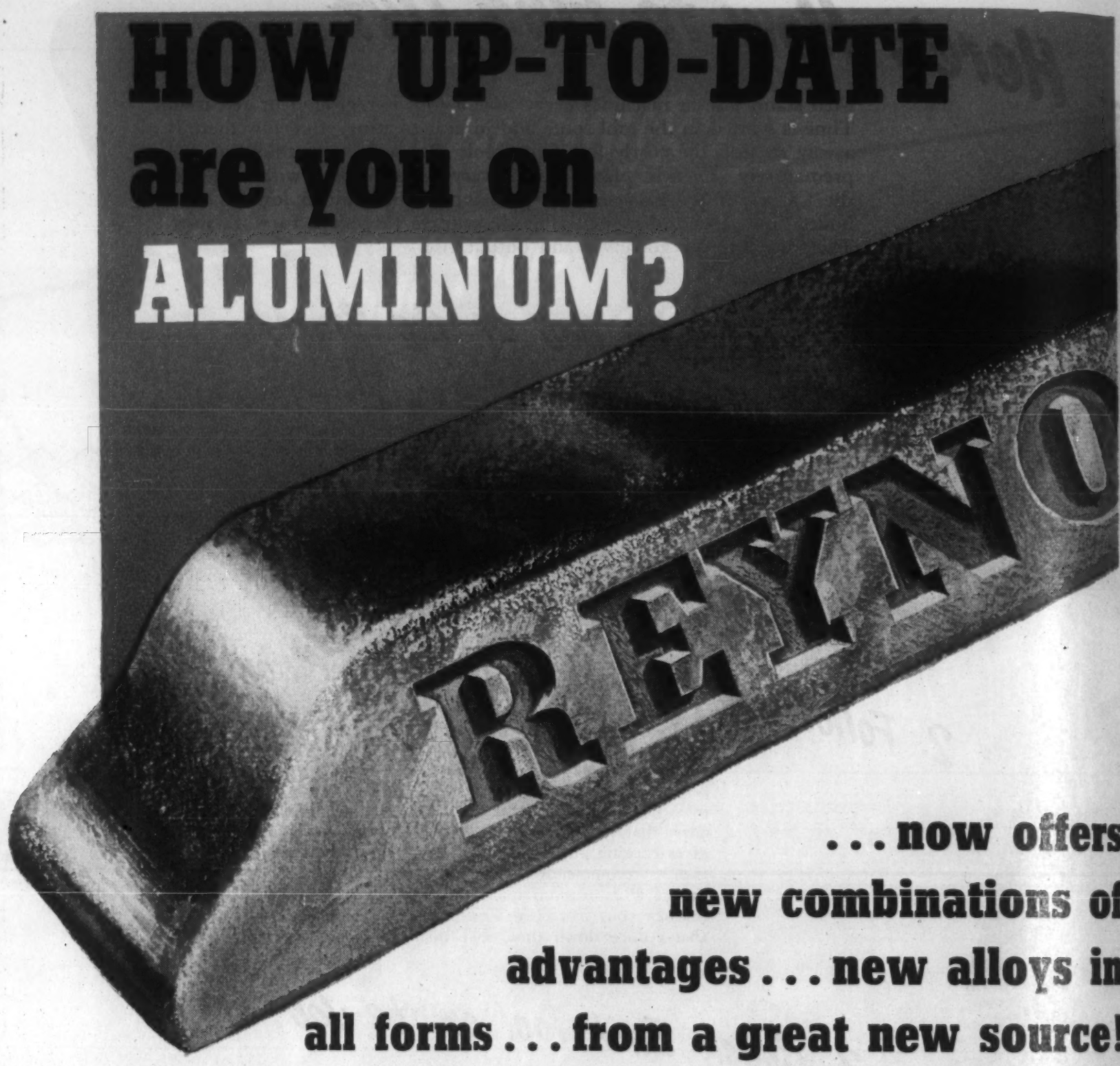
3. Check Each Tool on the Job!

How many pieces does each tool produce between grinds? Which tools fail too soon in service? Answers to those questions give you a yardstick to use in improving tool performance. And for personal help with your job analysis plan, call your nearby Carpenter representative. He knows tool steel from A to Z and can provide real engineering help.

Carpenter MATCHED TOOL STEELS

BRANCHES AT
Chicago, Cincinnati, Cleveland, Detroit, Hartford, Indianapolis, New York, Philadelphia, St. Louis

HOW UP-TO-DATE are you on ALUMINUM?



. . . now offers new combinations of advantages . . . new alloys in all forms . . . from a great new source!

Consider aluminum today in terms of recent advancements — particularly the new lightweight, high-strength aluminum alloys developed by Reynolds metallurgists.

For example . . .

CONSIDER R301, the new Reynolds alloy with a typical tensile yield strength of 60,000 p. s. i., superior workability, good corrosion-resistance, excellent spot-welding characteristics.

CONSIDER R303, another new Reynolds alloy with even higher tensile yield strength—higher, in fact, than any aluminum alloy used in the past. In addition, R303 has splendid corrosion-resistance.

CONSIDER ALSO R317, Reynolds new free-machining alloy.

And finally, consider all Reynolds aluminum alloys in terms of these additional advantages . . . ease of fabrication and assembly . . . thermal and electrical conductivity . . . heat and light reflectivity . . . non-magnetic, non-sparking and non-toxic qualities . . . pleasing appearance . . . new low costs.

Consider Aluminum—Consult Reynolds.

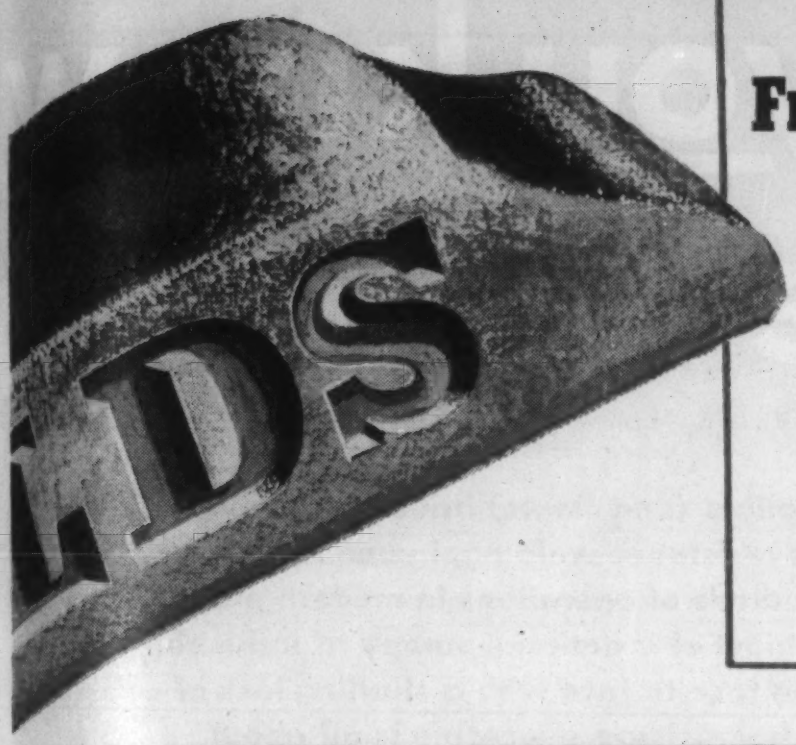
Keep your dollars fighting . . . Buy MORE War Bonds

REYNOLDS METALS

REYNOLDS ALUMINUM

The Great New Source of

INGOT · SHEET · SHAPES · WIRE · ROD · BAR · TUBING · PARTS · FORGINGS · CASTINGS · FOIL · POWDER



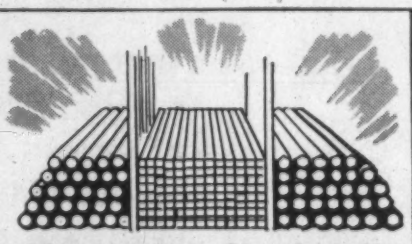
From Rivets to Armor Plate: Consult Reynolds

Today Reynolds Metals is sweeping forward as the nation's great new source of all forms of aluminum. Let Reynolds demonstrate what this all-out, tradition-free effort can do for you. Service offices located throughout the country.

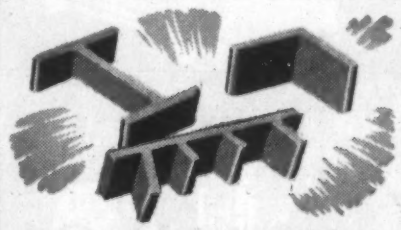
See the Reynolds catalog in Sweet's—or write for bulletins outlined in the paragraphs below.

SHEET AND PLATE. Standard gauges, sizes, alloys. Special items. Bulletin 22-A gives specifications, ordering data, etc. 8 pp.

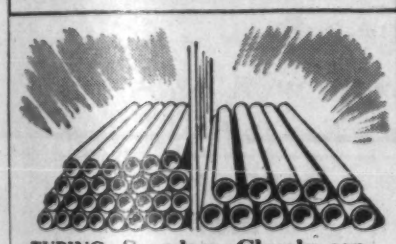
WIRE. Cross sections less than ⅛ inches. See Bulletin 31-A for specifications, ordering data, etc. 12 pp.



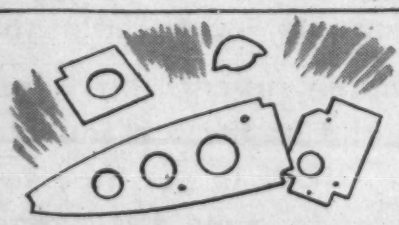
ROD AND BAR. Sizes from ⅛ inches to 8 inches for forging and machining. Bulletin 31-A gives complete information.



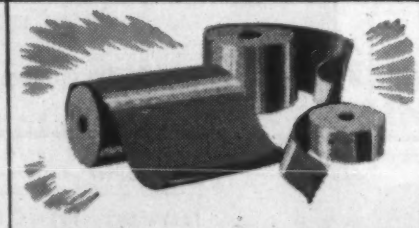
SHAPES. Rolled and extruded sections to fulfill individual needs. See Bulletin 35-A for full information. 8 pp.



TUBING. Seamless. Closely controlled as to quality and dimensions. See Bulletin 17-A. Specifications, ordering data, etc. 8 pp.

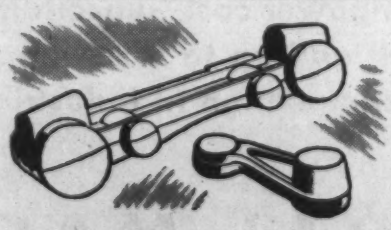


PARTS. Fabrication at aluminum source saves manpower, plant space, scrap and transportation. Ask for further information.

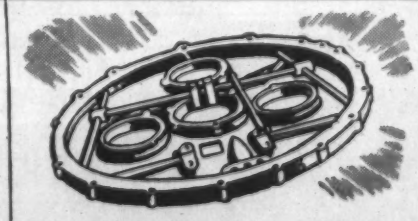


FOIL. For years the largest producer of light-gauge aluminum for packaging, technical and insulation purposes. Bulletin on request.

POWDERS AND PASTES. For aluminum coatings. Bulletin 21-A gives forms, applications, evaluations. 20 pp.



FORGINGS. Production capacity up to 2,000,000 units per month. Ask for details.

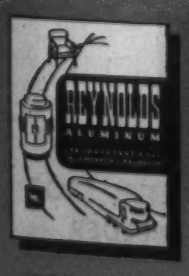


CASTINGS. Permanent mold and sand. Produced in one of industry's most modern plants. Ask for further information.

FREE! Many of the bulletins mentioned above belong in your files for quick reference. Please use coupon in requesting.

Reynolds Metals Company
Aluminum Division
2518 South Third Street, Louisville 1, Kentucky
Send post-free material I have listed:

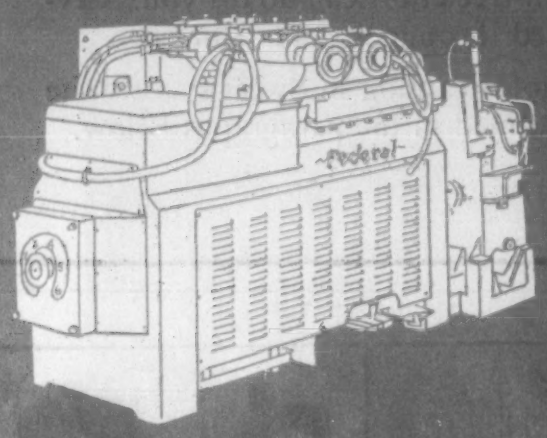
NAME_____
FIRM_____
STREET_____ TITLE_____
CITY_____ ZONE_____ STATE_____



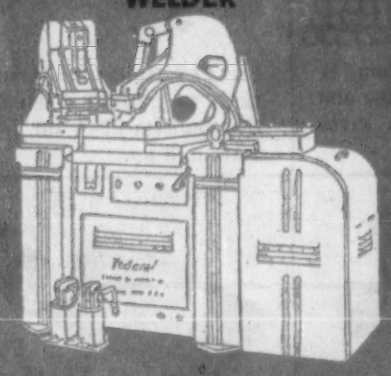
DON'T MISS THIS!

"Reynolds Aluminum, its Important Role in Tomorrow's Products," is of direct interest to every one concerned with design and production. 16 pages packed with useful information.

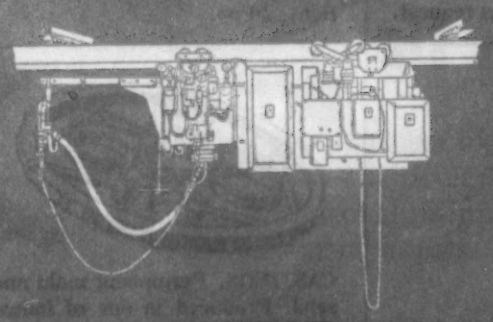
What do you know about resistance welding?



UTILITY BUTT AND FLASH WELDER



SASH WELDER



GUN WELDER

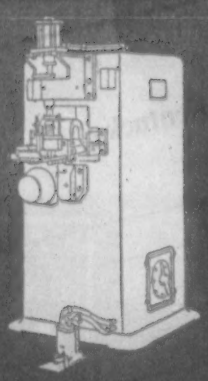
Millions of dollars (and hours) have been saved by the application of resistance welding, in one form or another, to literally hundreds of operations in modern manufacture . . yet in the midst of a national survey of industrial uses we have come face to face with a startling lack of understanding of what resistance welding is all about.

That this is true of top executives and factory men alike makes it almost a national emergency from our point of view . . . First because of the millions of dollars and production hours that other plants are losing (and perhaps yours is one of them) in fabrications and assemblies *that could be done better with resistance welding* . . . And also because it is obvious that *we* have not provided *you* with adequate, up-to-date information.

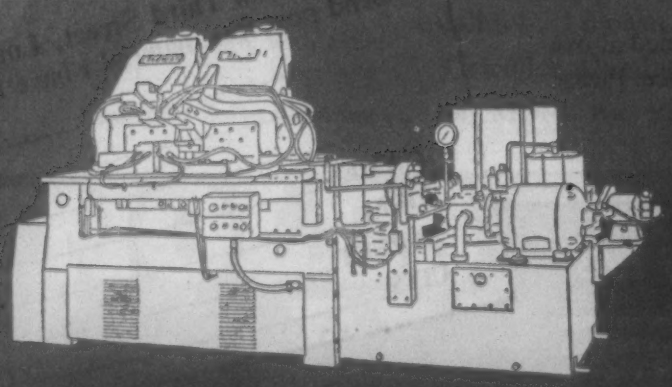
In the meantime, events have moved with relentless measure to point up the fact that *in addition to the big war job still ahead,* NOW is the time to put your production house in order to meet the converting demands of a goods-hungry world.

The problem will be . . . to make Quality + Quantity + Higher (than prewar) manpower cost + uncertain material and distribution costs, all add up to a selling price that will survive the fiercest competition in industrial history.

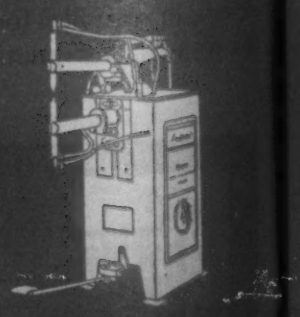
THE FEDERAL MACHINE A
200 DANA ST.



POT HANDLE PERCUSSION WELDER



HEAVY DUTY FLASH WELDER (1000 KVA)



UTILITY SPOT WELDER

about ?

You know that the required factor in the above problem, without which it CANNOT add up to a solution, is *increased efficiency in production.* If you apply to this challenge everything you have learned from your war experience plus *everything you can learn from the experience of others* it will still be a battle.

Federal is prepared to make available to you a wealth of information on the application of resistance welding in all of its phase to *better and faster production* (and don't say this cannot apply to your problem until you have the facts). We want to tell you about applications for resistance welding never before believed practical . . . We want to show you new ways to make profitable use of resistance welding equipment you may now have . . . to bring you up to date on the facts about resistance welding as a tool for modern production.

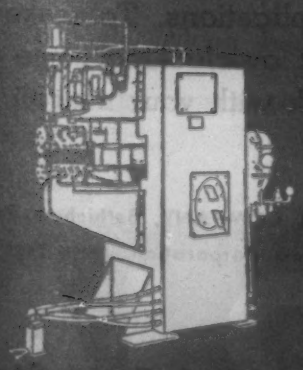
Federal is ready to help, if you will tell us WHAT YOU WANT TO KNOW ABOUT RESISTANCE WELDING.

Write today, stating your problem, bearing always in mind that in resistance welding, "*the name of authority is*

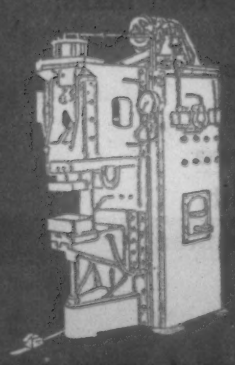
Federal

AND WELDER COMPANY

WARREN, OHIO



SEAM WELDER



PROJECTION WELDER

VERSATILE MODERN PRODUCTION TOOLS

ALUMINUM WELDERS

The limited plastic range of aluminum alloys has always made the welding of these metals an extremely critical problem, has caused many experts to claim that it cannot successfully be done. That it can, has been convincingly proved by the development of resistance welders, both spot and seam welding types, which are now producing aluminum welds of such high quality as to be acceptable for aircraft and other critical parts.

The Federal Machine and Welder Company recently delivered the largest and most modern roll-spot aluminum welder ever built, capable of welding two sheets up to 3/16" thickness . . . has others available, including spot welders capable of welding two aluminum alloy sheets up to .125" gauge at 150 spots per minute.

NEW SMALL SPOT WELDERS

Soon ready for distribution will be several improved models of small spot welders, so versatile in their usefulness and so low in cost that such users as garages, small metal fabricating shops and factory maintenance departments will find them valuable tools. Information on them is available through The Federal Machine and Welder Company.

RESISTANCE WELDING IN MAINTENANCE

Speaking of maintenance department uses, several plants where application of resistance welding would be least suspected have found small, low cost welders highly profitable for a variety of demands, from repairing or making of sheet metal safety housings to the patching of machine and electrical equipment parts.

2,000 KVA FLASH WELDERS

Among the recent special machines produced by Federal Machine and Welder Company are several 1000 KVA flash welders delivered to a foreign power as part of a complete production plant for making seven to ten foot diameter bearing rings, from hot rolled steel bar stock. Coming up are others of even greater KVA capacity. These particular rings were for tank turrets, but such welders are adaptable to handling large ring gear blanks, locomotive tires . . . many types of bars or rails up to 20 square inches cross section.

OLD TIMER . . . NEW SLOGAN

After several years total absorbtion in war work The Federal Machine and Welder Company,* oldest maker of resistance welding equipment, is planning its return to active contact with peace time fields . . . has a new slogan: "In resistance welding, the name of authority is FEDERAL".

Easy to use ... and so many places to use them

BETHLEHEM CARBON TOOL STEELS

Your tailor does not try to make one suit of clothes fit hundreds of different men. But in the case of carbon tool steel, the metallurgist is faced with the task of developing a single product for hundreds of different purposes—so that *your* job of selecting steel will be simplified.

Bethlehem carbon tool steels, with their tremendous range of applications, are the wheelhorses of the tool room. Here are a few of the characteristics that make these steels suitable for so many different tasks:

★ High, uniform hardness
★ Uniform grain structure
★ High abrasion-resistance
★ Excellent machineability
★ Simplicity of heat-treatment

Because of the high carbon content, special melting technique, and restrictions on incidental elements, Bethlehem carbon tool steels are produced under unusually rigid controls. They are not easy steels to make. But they *are* easy steels to use, as thousands of customers can testify.

When you purchase Bethlehem carbon tool steel in the X, XCL, or XX grade, you are buying a product that is generally regarded as the standard of the industry for hundreds of applications. To make sure that you are not overlooking some of its many uses, check with your nearest Bethlehem distributor.

BETHLEHEM STEEL COMPANY, Bethlehem, Pa.
Bethlehem Steel Export Corporation, New York City

BETHLEHEM STEEL

X, XCL, XX ... *members of Bethlehem's BIG 8 Tool Steels*

Another Alcoa Contribution to greater engine reliability...

You can safely operate Alcoa Aluminum bearings at higher loads. This is a proved fact—proved repeatedly under scientific control on the test floor and under the varied circumstances of severe routine service.

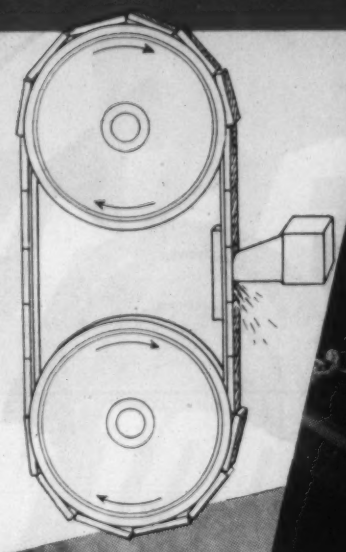
These bearings are bearing metal clear through. Alcoa bearing alloys offer excellent bearing characteristics. Their high heat conductivity lowers surface temperatures.

Don't be surprised when an engine builder gives you this evidence of a big step forward—"We're using Alcoa Aluminum bearings for better performance and greater reliability." A number of manufacturers have standardized on them for their heavy-duty work. ALUMINUM COMPANY OF AMERICA, 2162 Gulf Bldg., Pittsburgh 19, Pa.

ALCOA FIRST IN ALUMINUM

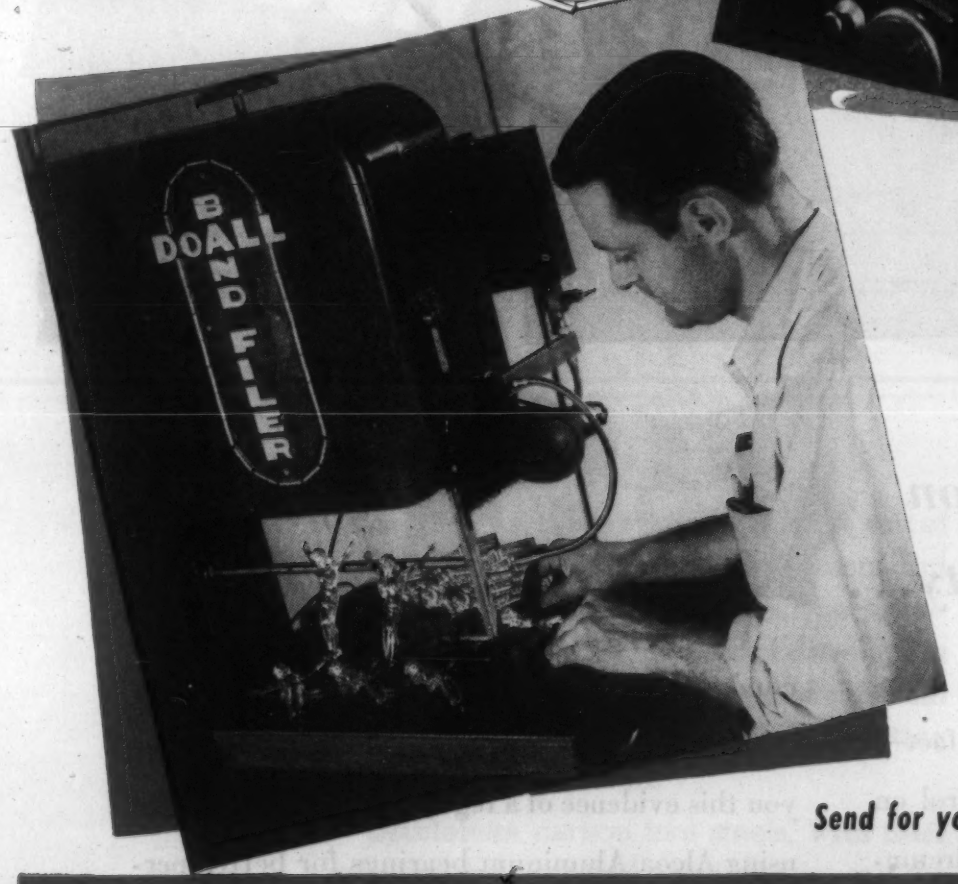
2 WAYS TO REMOVE FLASH

Both DoALL



You can do it on the DoALL Contour Machine or on a DoALL Band Filer. Both accommodate the ⅜" File Band which finished these metal statuettes at the rate of one per minute.

The DoALL method is a smooth, continuous, one-way operation with no loss of time, motion or energy. Today's fastest way to finish parts or products made from metals, alloys, plymetals. And, it's 4 times faster than jig filing, 9 times faster than hand filing.



Contour Machine — Thousands are in use today shaping parts used in important war equipment. Although used primarily for internal and external sawing, file bands are included as standard equipment with each DoALL Contour Machine.

Band Filer — For continuous filing here's the best solution — a variable speed precision machine that accommodates work up to 6" thick. The 18" square work table tilts for angle filing. Occupies only 27" x 34" floor space.

Send for your copy of circular BAND FILING TO PRECISION TOLERANCES

DoALL

INDUSTRY'S NEW SET OF TOOLS

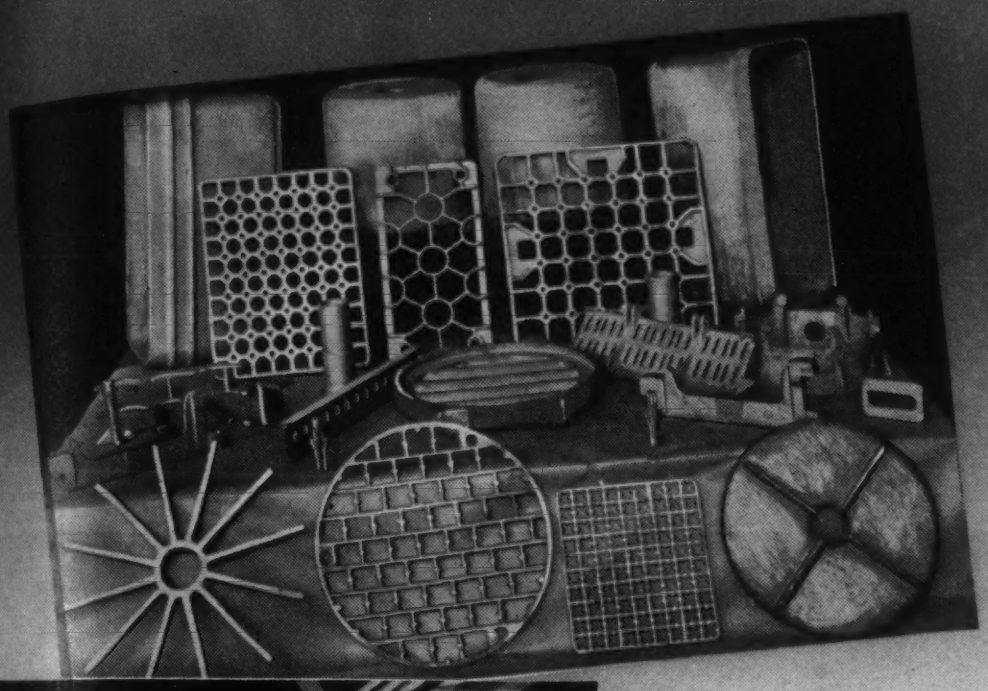
CONTINENTAL MACHINES, INC.

1343 S. Washington Ave. • Minneapolis 4, Minn.

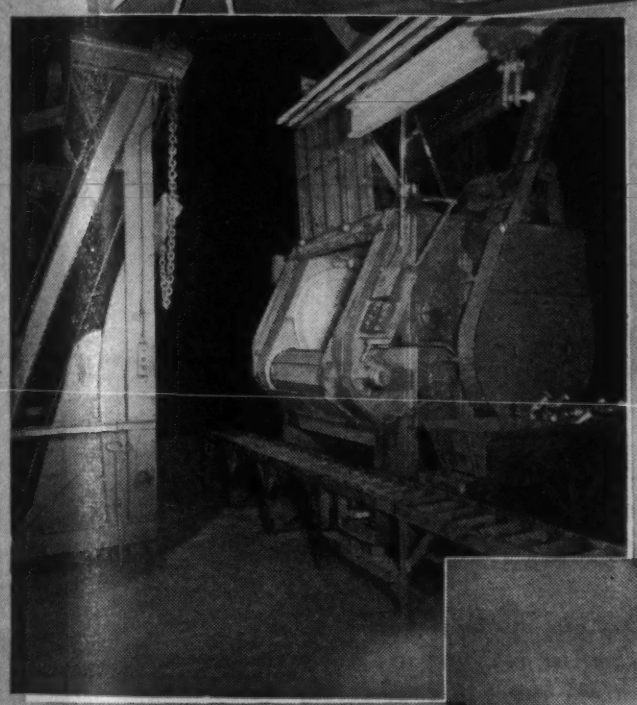
Sales & Service Offices: Baltimore, Birmingham, Boston, Chicago, Cincinnati, Cleveland, Dallas, Dayton, Denver, Detroit, El Paso, Erie, Grand Rapids, Hartford, Houston, Indianapolis, Kansas City, Los Angeles, Milwaukee, Minneapolis, New York, Orlando, Philadelphia, Pittsburgh, Providence, Reading, Rochester, Rockford, St. Louis, San Francisco, Seattle, Statesville, Syracuse, Toledo, Tulsa

There's No Substitute For Alloy Experience —

"SWESCO" ALLOY CASTINGS

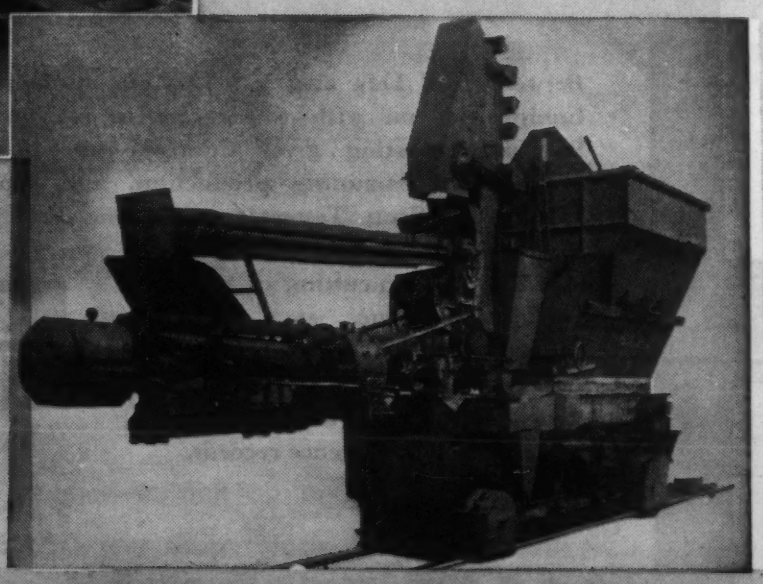


. . . In Greater Demand Than Ever Before . . . For 32 Years "Know-How" Go Into Their Making!



As early as 1912, the Swedish Crucible Steel Company was prominent in the development of nickel-chrome heat resistant castings, designed to resist oxidation, corrosion, and abrasion. Today this early experience is treasured, for the knowledge and skill so gained has proved invaluable in producing "SWESCO" Alloy Castings of superior quality. Evidence of this is their ever-increasing demand by manufacturers who recognize "SWESCO" superiority.

MODERN FACILITIES, SKILL AND CARE . . . MEAN SAVINGS ON YOUR ALLOY CASTINGS REQUIREMENTS.



Pioneers in the development of Alloy Castings to meet today's Industrial demands

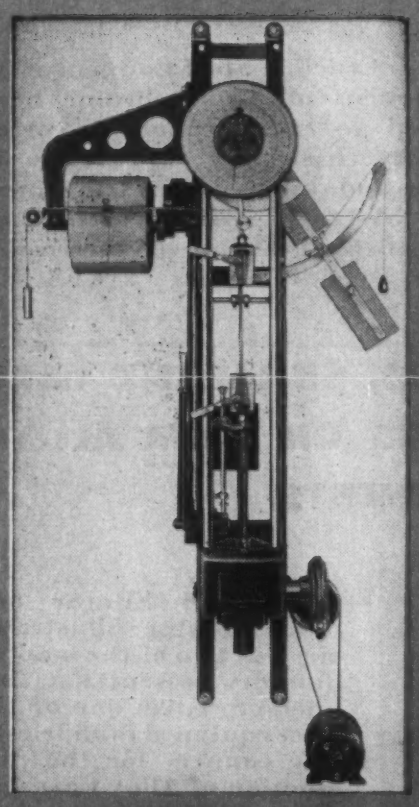
The Sand Slinger and Wheelabrator illustrated are but two of the modern foundry essentials that make Swedish one of the best equipped foundries in the country for the production of Alloy Castings. Our skill, care, modern equipment and, above all, experience can be of real service to you on your Alloy Castings requirements, and we welcome the opportunity to assist you in any way possible. For detailed information please write, wire or telephone Dept. SCS-54.

Swedish CRUCIBLE STEEL COMPANY

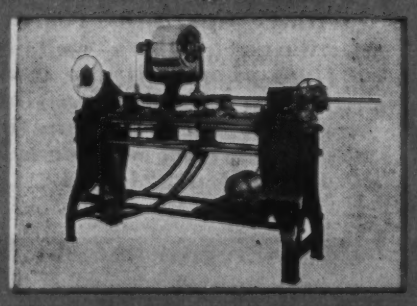
Serving Industry For More Than Thirty-Two Years

8561 BUTLER AVENUE . . . DETROIT 11, MICHIGAN

Plan your Post-War Testing Equipment NOW

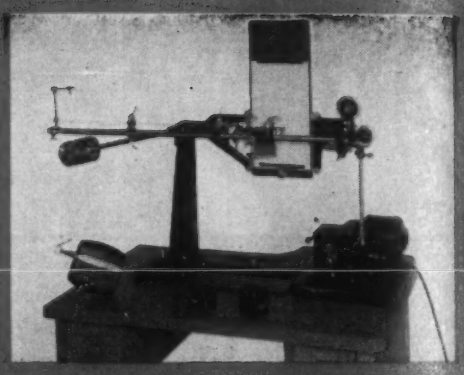


Model J-5 for wire. Capacity from 0 to 1,000 lbs. tensile.



Model Q-7 heavy duty wire tester with capacity of 2,000 lbs.

*This exclusive Incline-plane *Scott Tester is expressly designed for testing the finest vacuum tube grid wires, having a capacity of 0 to 2,000 grams. This machine produces a picturized curve of the behavior of the wire under load, and experience has demonstrated the durability of a wire can be pre-determined from the pattern of its curve.



Between V-E Day and V-J Day, let us help you plan the Testing Equipment you wish to acquire to set up an Adequate Testing Routine. "Testing gives Control"—speeding research, facilitating purchasing, promoting production, and proving quality. The 60 models of *Scott Testers span the needs of wire and strip testing for tensile, hysteresis, twist, flexing, compression-cutting of rubber covering, etc., etc., from finest filament to 1 ton tensile. Results, in the form of picturized charts, are ideal for easy reading and valuable as reference records.

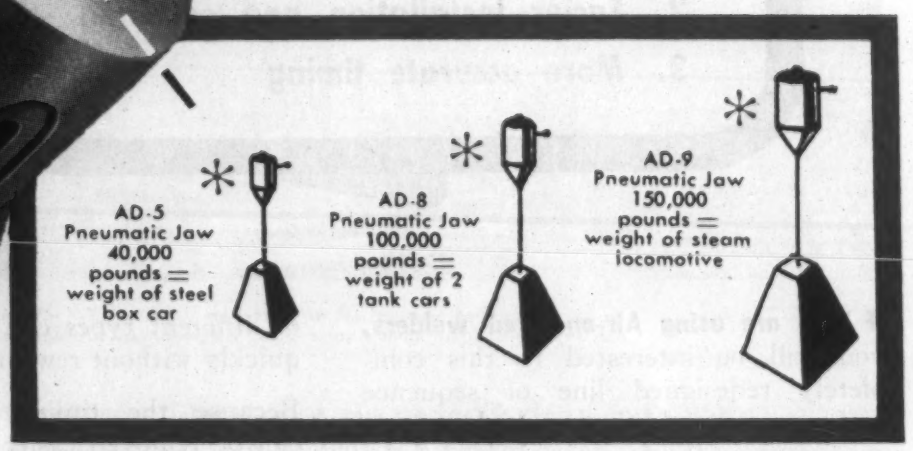
SCOTT TESTERS

*Registered Trademark

SCOTT TESTERS, INC. 65 BLACKSTONE ST. PROVIDENCE, R. I.

Scott Testers — Standard of the World

THE JAW WITH THE 75-TON BITE!



FOR GRIPPING extrusions, rolled stock, tubing and narrow sheet while straightening, contouring, testing, stretching—or for *any other* application where extreme tension is applied to a workpiece—the Hufford Pneumatic Jaw is the ideal solution to gripper problems!

It holds securely under any applied tension up to 150,000 pounds . . . accommodates any shape stock that fits within 4," 6" or 8" diameter circle . . . and releases the workpiece instantly without freezing.

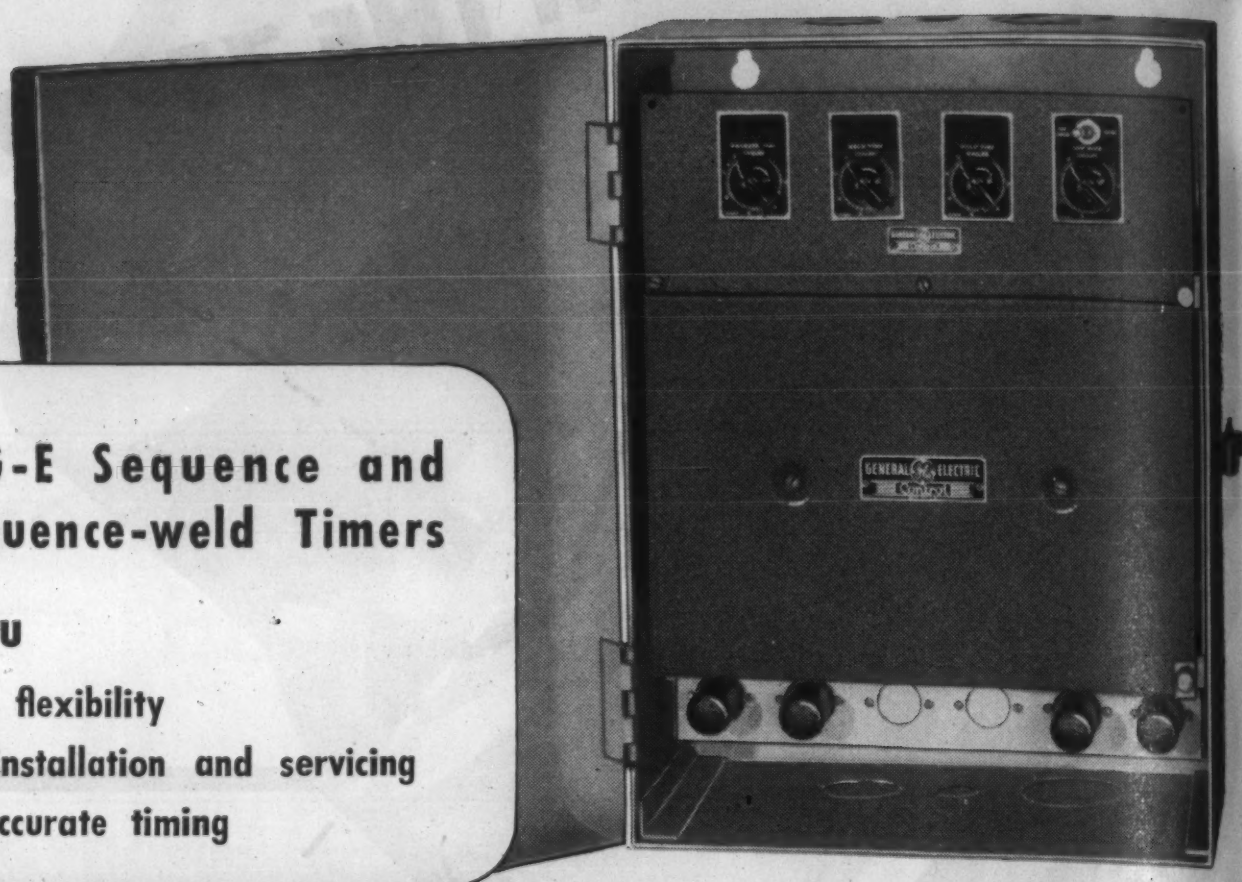
Hufford Jaw capacities are 20, 50 and 75 tons for the three sizes—ample for the most severe types of service. *If you have a material gripping problem, write for descriptive Bulletin A-1 which gives complete details and will help suggest many applications for the Hufford Jaw in your metal-working operations.* Or outline your problem to our engineering staff for a prompt recommendation! Hufford Machine Works, Inc., 207 North Broadway, Redondo Beach, California.

Hufford MACHINE WORKS, INC.

MANUFACTURERS OF HYDRAULIC METAL-CONTOURING EQUIPMENT

Announcing

AN IMPROVED LINE OF TIMERS FOR RESISTANCE-WELDING MACHINES



now **G-E Sequence and Sequence-weld Timers Offer You**

1. **Greater flexibility**
2. **Easier installation and servicing**
3. **More accurate timing**

A credit to your plant, this sequence-weld timer has been designed to meet the New American War Standards of Controls for Resistance Welding Machines (C52.4).

IF YOU are using Air-operated welders, you will be interested in this completely redesigned line of sequence and sequence-weld timers which provide consistent and automatic timing of the complete welding cycle. It includes controls for all standard combinations in which ignitron contactors or synchronous-precision timers are used.

You can change welding sequence easily—Each control is constructed in such a way that the timing control section can be removed in less than a minute—and placed in another machine. This feature is particularly desirable for assembly-line welding because a single spare unit can be used to replace any one of a number of similar timing control sections. And, consequently, servicing will not hold up production.

Also, when production-line requirements change, timing control sections of different types can be interchanged quickly without rewiring.

Because the timing control section can be removed easily (making readily accessible the terminal boards and mounting holes), installation of the complete timer is greatly simplified.

A new and more accurate timing circuit provides consistent welding speed as required for high production welding with short timing intervals, despite nominal variations in line voltage.

Long tube life—The new G-E metal thyratron tube, installed in the timing circuit, will keep this control operating precisely for a long time.

Remote operation—For the convenience of the operator in making adjustments, the timing-control station can be removed easily and mounted on the welding machine or elsewhere.

Built for Your Serviceman

These redesigned controls have many additional features which simplify routine inspection and servicing. Standard industrial-type relays, with which your electrician is familiar and which are easy to service, have been used throughout. Also, by redesigning the wiring system and mounting most of the small resistors and capacitors on a terminal board, servicing has been greatly facilitated.

Need More Information?

Your local G-E office will be glad to tell you more about the jobs that these controls can do—and are doing. Or write directly to us for more information. *General Electric Co., Schenectady 5, N. Y.*

GENERAL ELECTRIC

645-35-8960

RESISTANCE-WELDING CONTROL

Buy all the Bonds you can—and keep all you buy

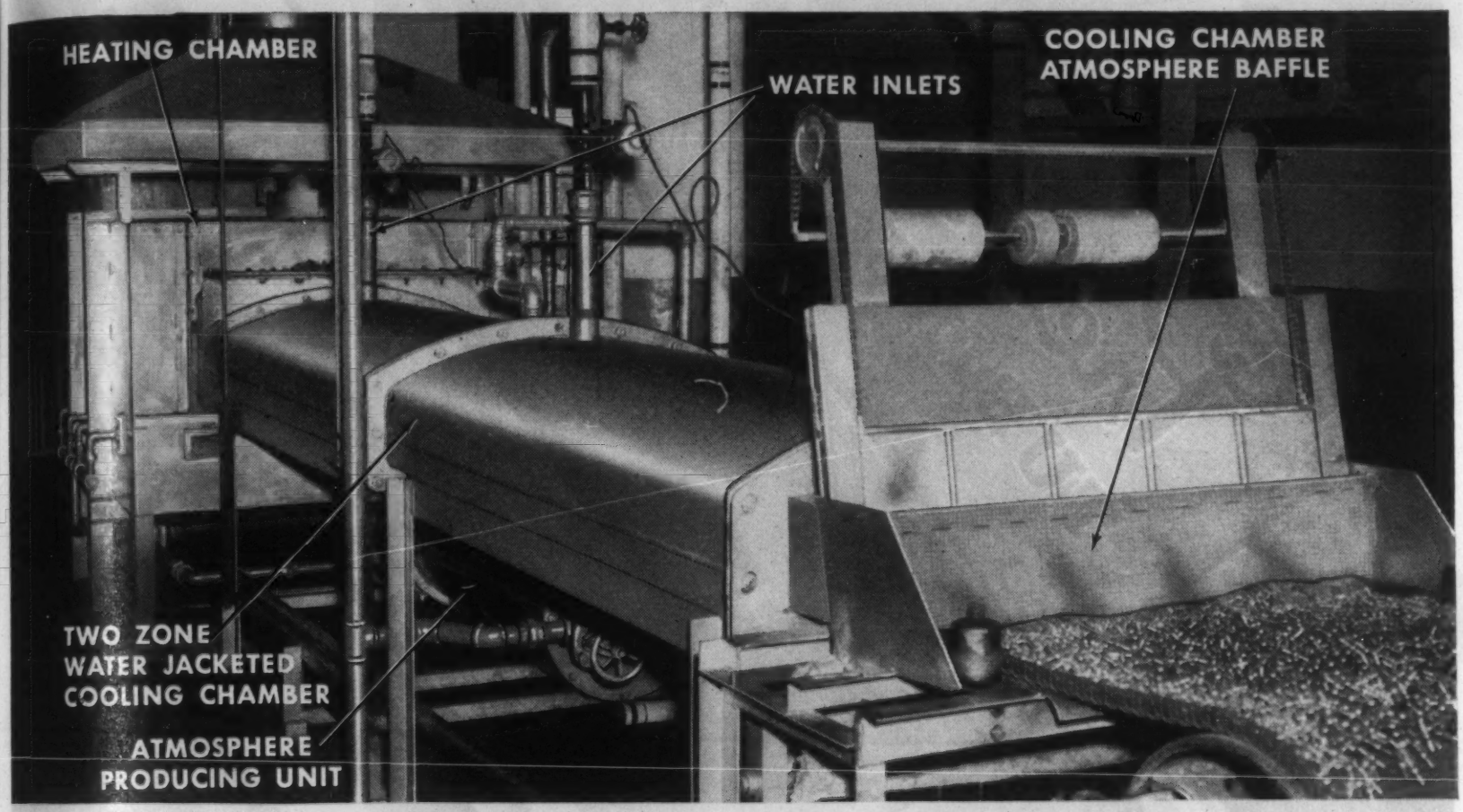
STEWART

THE BEST INDUSTRIAL FURNACES MADE

No. 57 OF A SERIES of Typical Installations

For HARDENING AND BRIGHT ANNEALING P-K PRODUCTS

at the Parker-Kalon Corporation, New York, N. Y.



Discharge end of Stewart Bright Annealing Furnace showing blanks for P-K Thumb Screws coming off the conveyor belt. At the time this photograph was taken, the furnace had been operating day and night for approximately 7000 hours without breakdown or trouble.

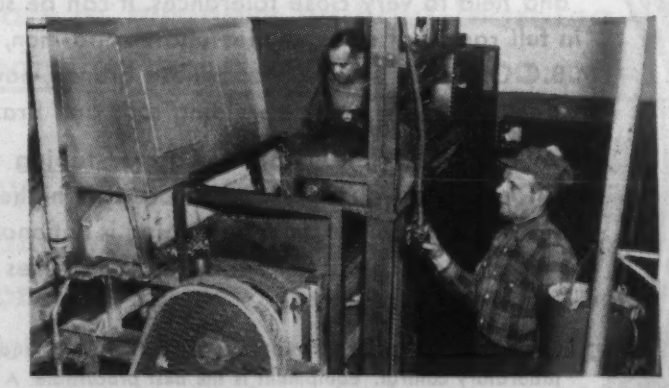
An important division of the Parker-Kalon operation is the Heat Treating Department. P-K Self-Tapping Screws, used in over 100,000 plants, must have sufficient surface hardness to form the thread in the metals, plastics, fibre, or hard rubber where fastenings are being made.

For this important hardening job, P-K use a Stewart Hardening Furnace which gives them a production of 600 to 800 pounds per hour. Stewart Gasifiers make oil economical for this full nickel chromium muffle unit. The 24-inch wide conveyor belt has an automatic take-up, and the quench tank is an integral part of the unit.

The Stewart Conveyor-type Hot Air Recirculating Unit at P-K has a production of 1000 pounds per hour of socket head cap screws, set screws, etc., drawn at temperatures up to 1200° F., with accuracy of 5° plus or minus.

The bright annealing of P-K Thumb Screws, etc. is done with a Stewart Full-Muffle Conveyor-type Bright Annealing Furnace. Since the installation of this furnace, it has been possible to eliminate all cleaning apparatus and to release six men formerly required for this operation to other work in the plant. They can now feed the work to the annealing furnace with the oil and grease from the machining operation still on them and have them come out perfectly clean and uniform.

This installation is typical of the industrial furnaces Stewart engineers are building every day, both large types to meet the specified requirements of manufacturers all over the continent, and a complete line of standard types.



Charging end of the Stewart Bright Annealing Furnace.

STEWART INDUSTRIAL FURNACE DIVISION of CHICAGO FLEXIBLE SHAFT CO.

***Main Office:* 5600 W. Roosevelt Road, Chicago 50, Ill. — *Canada Factory:* (FLEXIBLE SHAFT CO., LTD.) 321 Weston Rd., So., Toronto 9**

A letter, wire or 'phone call will promptly bring you information and details on STEWART furnaces, either units for which plans are now ready or units especially designed to meet your needs. Or, if you prefer, a STEWART engineer will be glad to call and discuss your heat treating problems with you.

We have been manufacturing brass rod, brass alloy rods, welding rods, etc. for over a quarter of a century. Our standard brass rod is free cutting, uniformly free from heat spots and held to very close tolerances. It can be supplied in full range of sizes, shapes and composition, such as M.B.C.O., Tobin bronze, manganese bronze, naval brass, etc.; also fumeless bronze welding rods and brazing wire.

SEAMLESS COPPER TUBES: Copper tubing (or pipe) manufactured in our mills is produced of highest quality virgin material. Our soft copper tubing is nationally known for its even, consistent temper. Furnished in sizes ⅜" O. D. to 3⅛" O. D.

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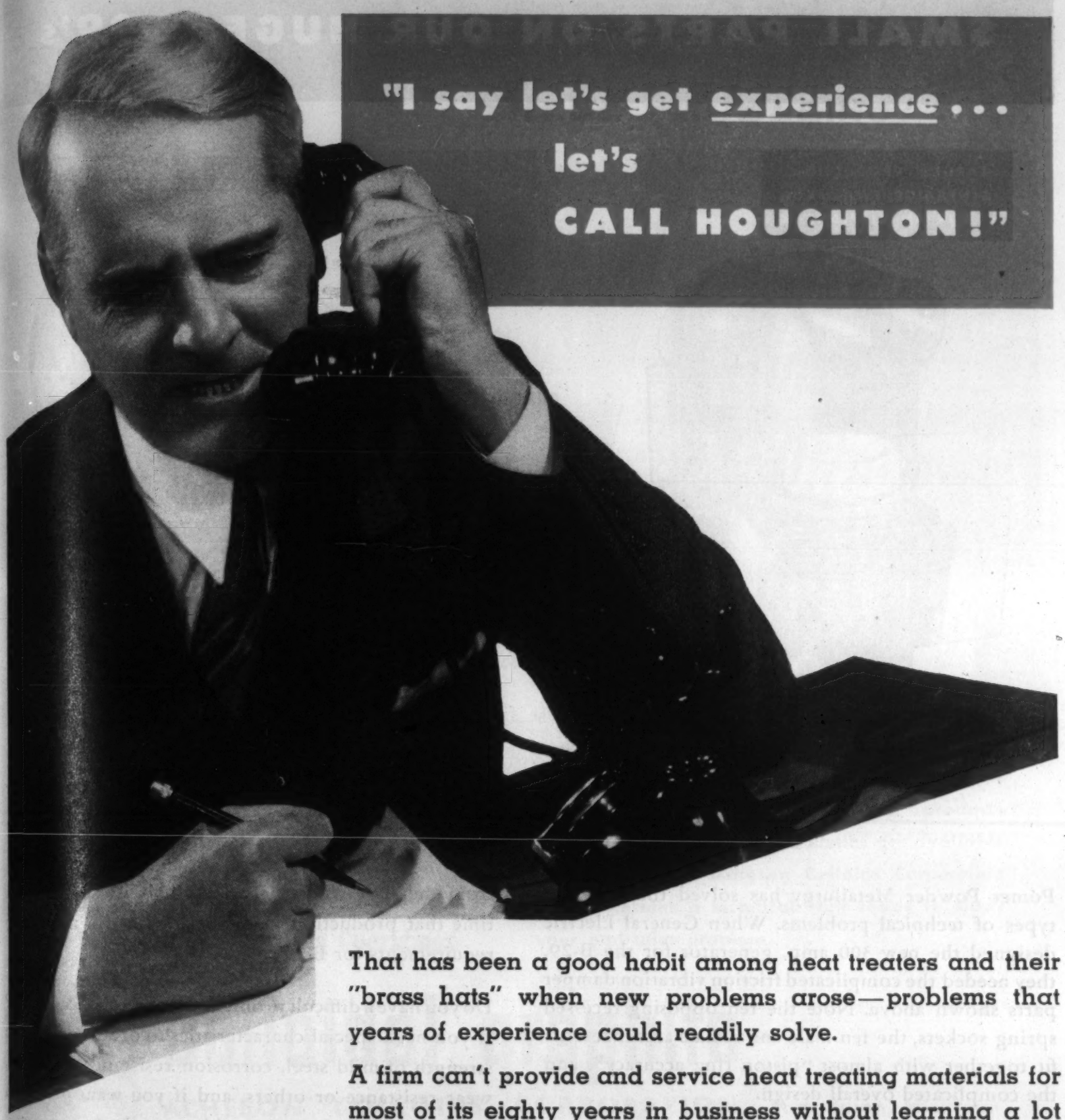

That has been a good habit among heat treaters and their "brass hats" when new problems arose—problems that years of experience could readily solve.

A firm can't provide and service heat treating materials for most of its eighty years in business without learning a lot of short-cuts and reducing shop troubles to a common denominator.

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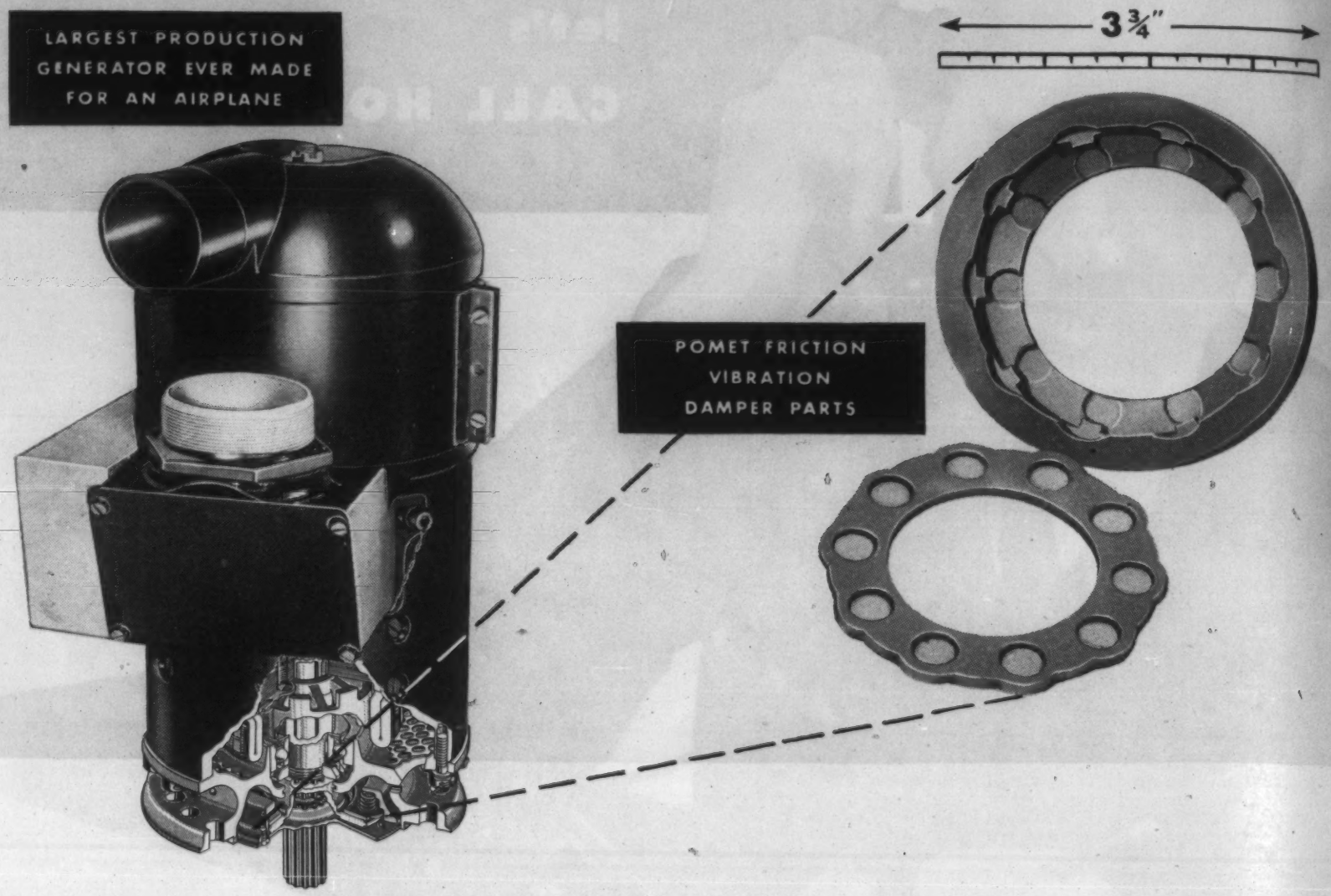

Pomet Powder Metallurgy has solved the toughest types of technical problems. When General Electric designed the new 300 amp. generator for the B-29, they needed the complicated friction vibration damper parts shown above. Note the ten opposing recessed spring sockets, the ten male and female arcs that must fit together with almost "piston ring accuracy", and the complicated overall design.

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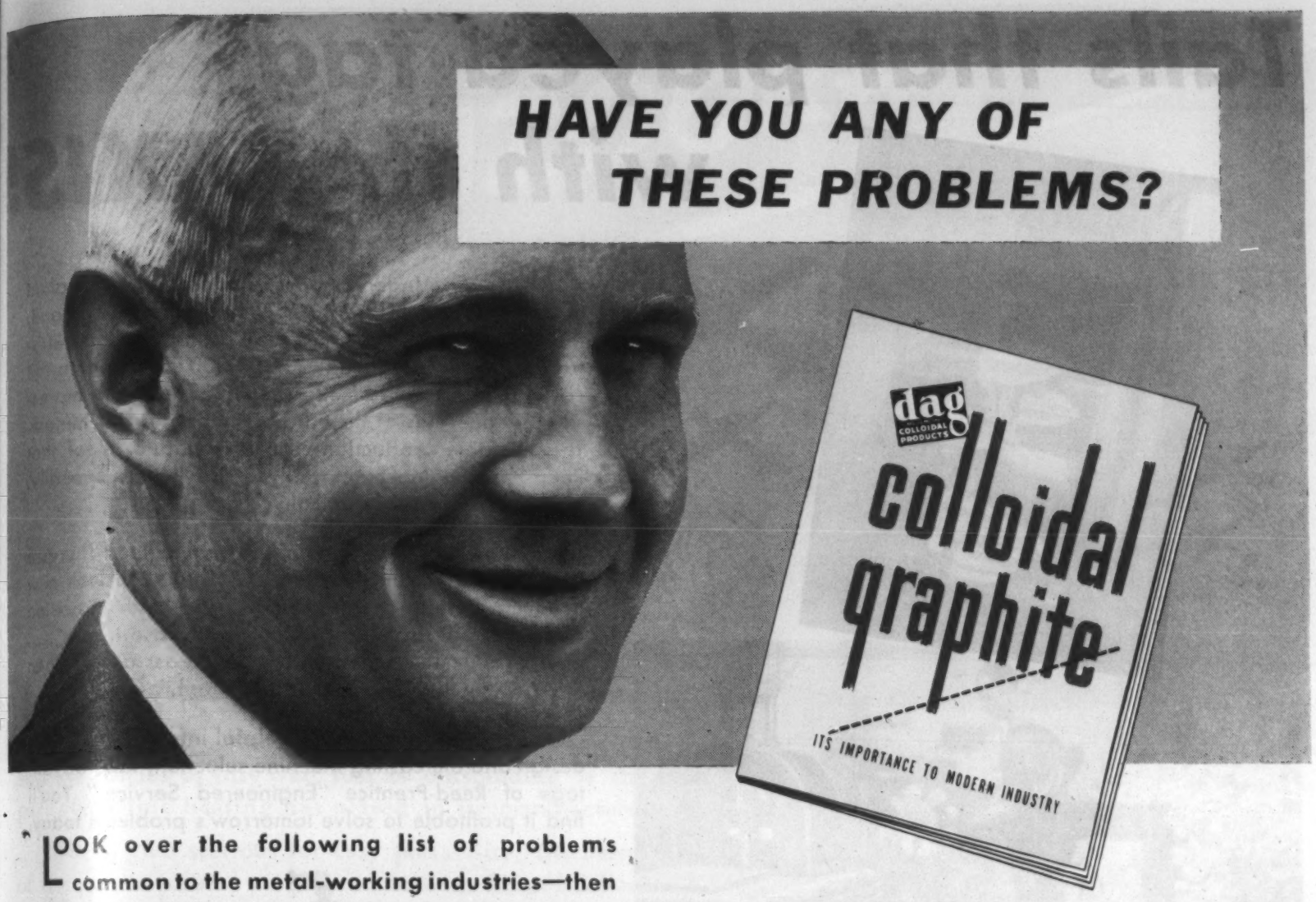

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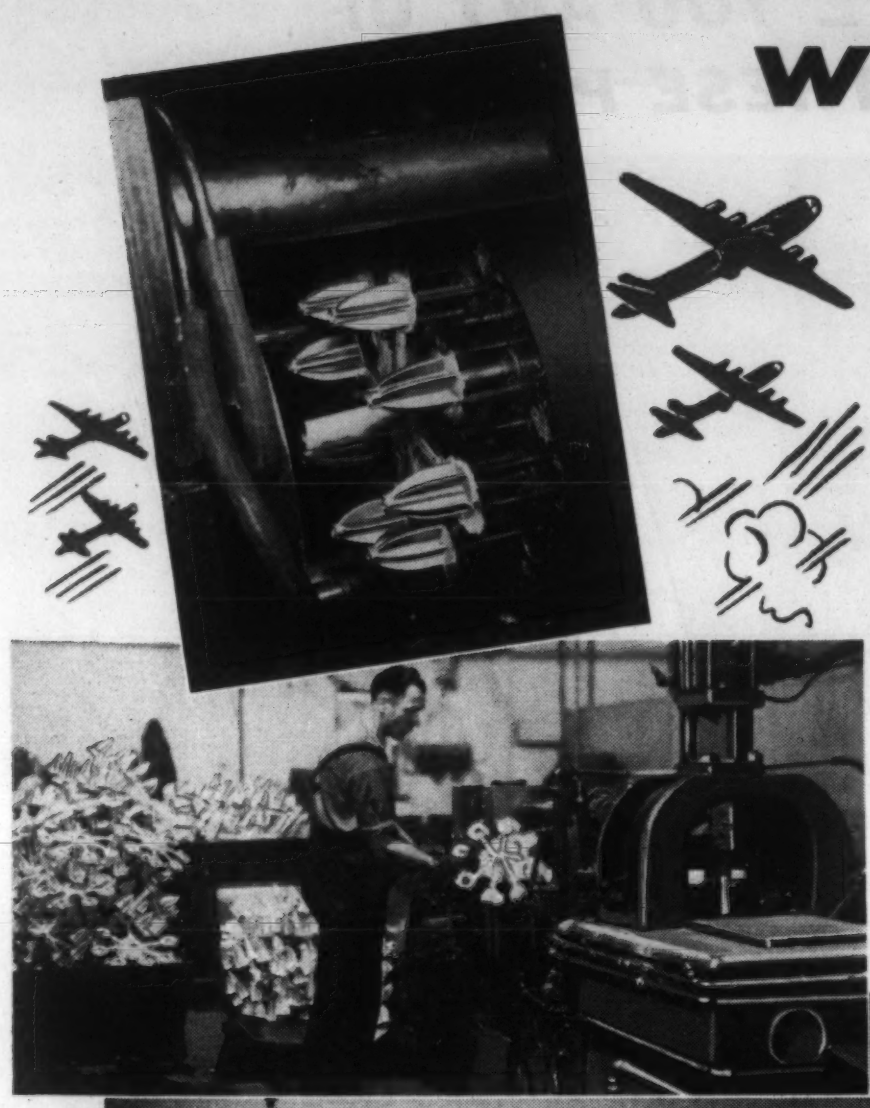

Under continuous operation in the plant of The Avon Die Casting Co., Birmingham, England, the Reed-Prentice No. 1½ die casting machine illustrated below produced 25,000,000 zinc bomb-tail castings at the rate of 32 a minute. The eight impression die operates at the rate of four shots per minute. This enviable production record is added proof that Reed-Prentice machines deliver the goods speedily, accurately and economically.

With the return of peace, Reed-Prentice No. 1½ die casting machines will help produce new products better, cheaper and faster with precision castings made from zinc, tin or lead base alloys . . . or from aluminum, magnesium and brass alloys when fitted with cold chamber attachment.

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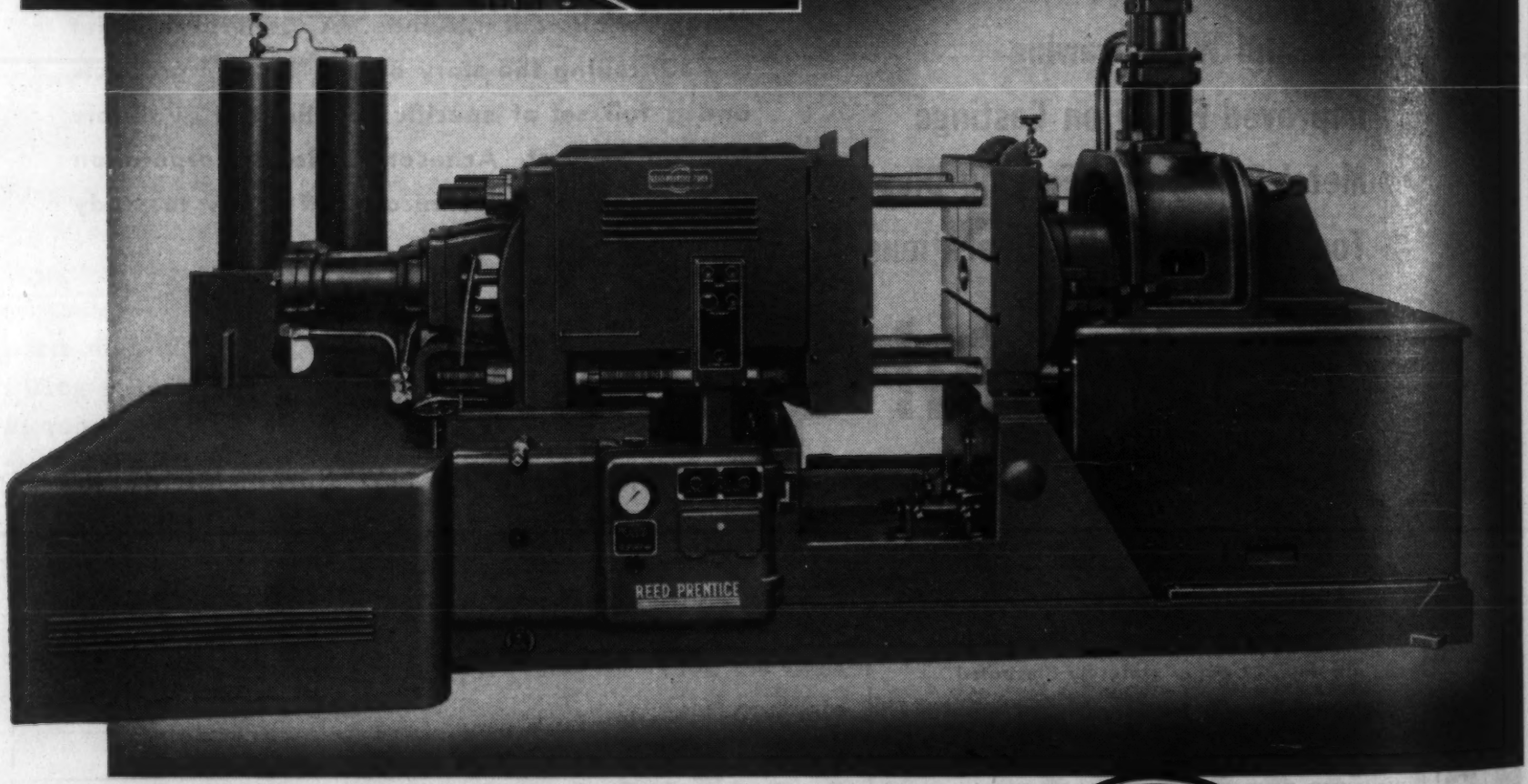

Reed-Prentice No. 1½ Die Casting machine for zinc, tin or lead base alloys.

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Made in two sections for easy portability, the barrel of the gun is jointed in the middle with flanged collars and three locking lugs.

One collar is brazed to the front section at the rate of 120 per hour. Four brazes are made simultaneously, on four separate bazookas, with *one* G-E 15-kw electronic heater. Another identical heater is used to braze the other collar to the rear section.

After brazing, the locking lugs are hardened in a third G-E 15-kw heater at the rate of 375 lugs, or 125 bazookas, per hour. Both the heating and the quenching cycles are automatically controlled.

This is another example of the way electronic heating is helping to speed war production. With this versatile process, you can braze, harden, anneal, or solder—and the heated zone can be confined within close limits. For details, simply contact the nearest G-E office, or write to General Electric Company, Schenectady 5, N. Y.

THIS MULTIPLE FIXTURE is used to harden the lugs on four barrels simultaneously. First, one lug on each barrel is heated and quenched. Then each barrel is rotated to place the lug in position within the heater coil, and the operation is repeated. The same procedure is followed to harden the third lug. This one heater, and one operator, perform the hardening operations on 125 bazookas per hour.

THREE G-E ELECTRONIC HEATERS are used in producing the bazooka, two for the brazing operations, one for hardening.

NO. 9 IN A SERIES OF CASE STUDIES ON THE ACCOMPLISHMENTS OF G-E ELECTRONIC HEATERS

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FAST PRODUCTION of lustrous deposits — is yours with Unichrome Alkaline Copper. Speed . . . smoothness of deposits . . . efficiency . . . and safety—have all been *proved* in the many large installations. And when you add economy of operation to these benefits, it's apparent why Unichrome Alkaline Copper will pay immediate dividends when it's time to meet post-war competition.

LOOK INTO THESE FEATURES

Unichrome Copper deposits are dense, unusually fine-grained, and adhere well. Their exceptional smoothness makes an excellent base without buffing prior to bright nickel. Where the base metal is rough, the plate can be buffed with minimum pressure.

In many plants today this process boosts production because of the high plating speeds obtained. A quick, simple cleaning cycle is used, and deposits need no activation before plating with other metals.

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CHROMIUM PLATING for wear-resisting, oil-retaining and other types of finishes.

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Cast to conform closely to final shapes, ArmaSteel reduces the amount of metal to be removed, eliminating up to 60 per cent of machining time. In addition, ArmaSteel gives 10 to 50 per cent better machinability with a 20 to 100 per cent increase in the number of parts finished per tool grind. Experience in the production of a particular gun part resulted in nearly 15,000 pieces being obtained per tool grind without the use of a coolant.

Gun parts weighing less than a pound, and Diesel locomotive pistons weighing more than 50 pounds, have been cast successfully with ArmaSteel.

To industries awaiting "Go Day" on civilian production we suggest keeping ArmaSteel's war record in mind when setting up production programs. Parts can be made faster, better, cheaper with ArmaSteel castings.

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- Cast to conform closely to final shapes.
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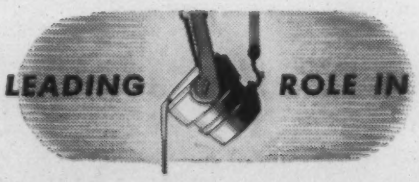
CAST FOR A LEADING  ROLE IN INDUSTRY

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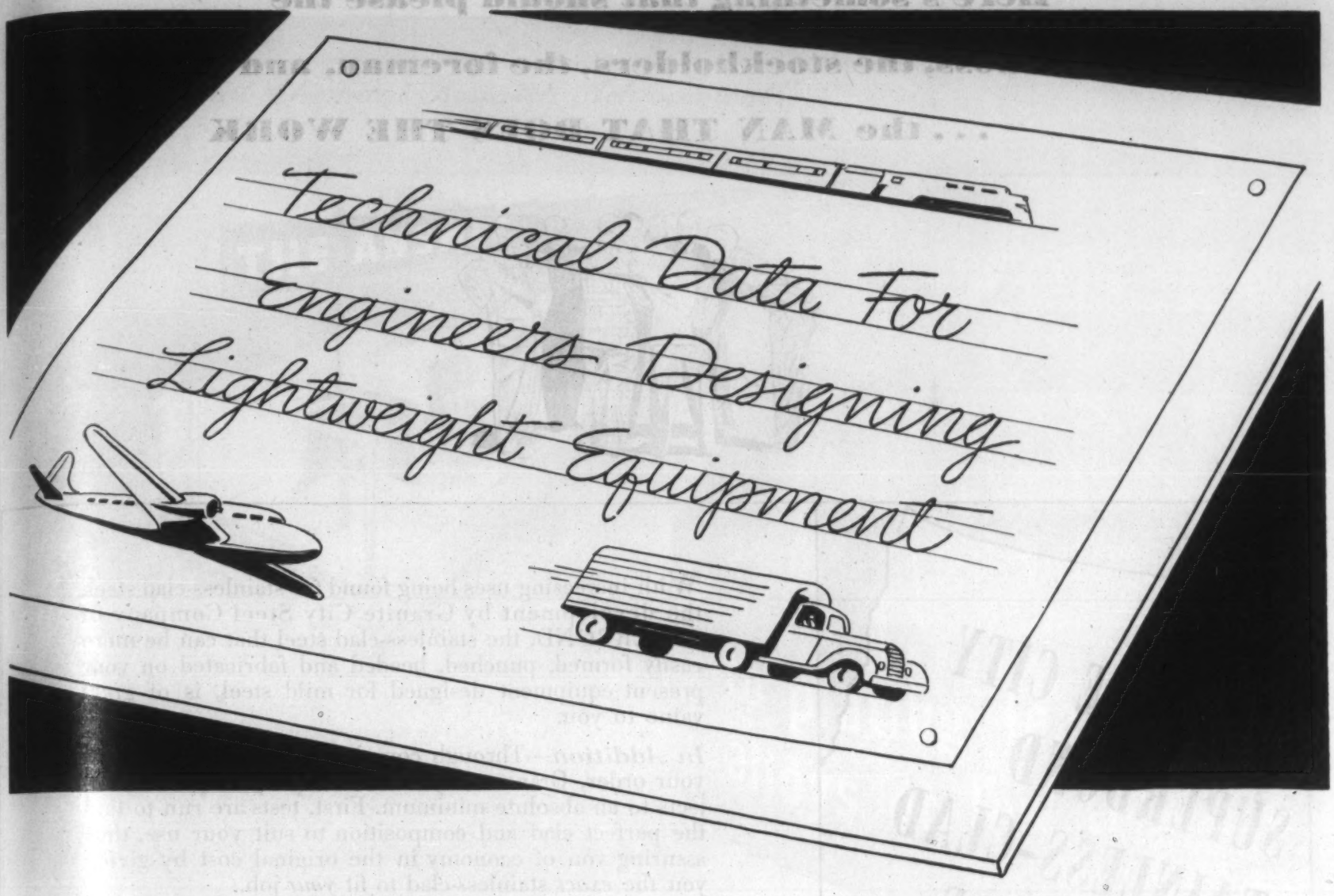

• You can get much useful information on the physical properties of the high-strength cold-rolled austenitic alloy steels by writing for the technical publications listed below.

All these papers are based on studies made at the research laboratories of Electro Metallurgical Company, and are part of a broad development program to find new or improved ways of using stainless and other alloy steels and irons.

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"Tension and Compression Stress-Strain Characteristics of Cold-Rolled Austenitic Chromium-Nickel and Chromium-Manganese-Nickel Stainless Steels" — a compilation of important physical data on austenitic chromium-nickel and chromium-manganese-nickel steels.

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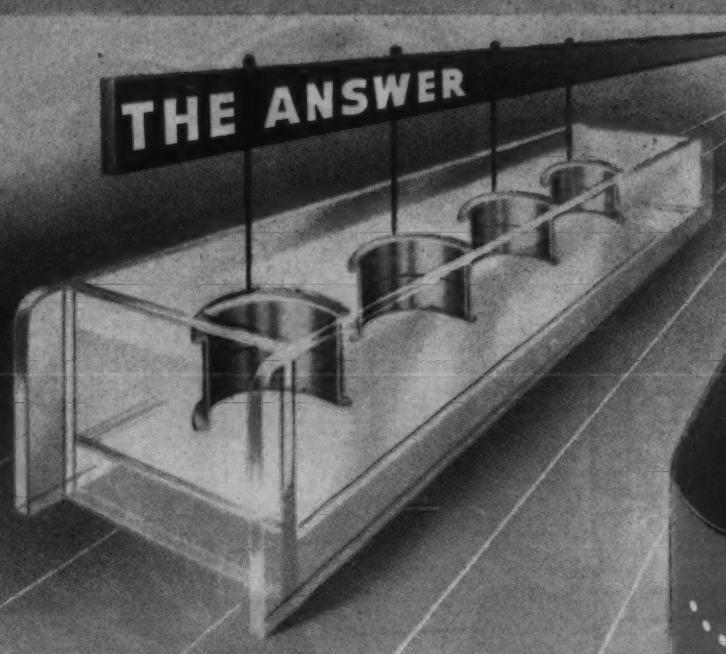

...to plating lead-tin alloys of low tin

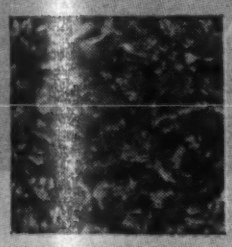

Fig. A: Lead Plating (100% Lead—0% Tin) *150 Diameters*

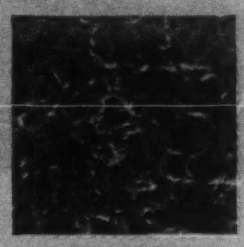

Fig. B: Lead-Tin Alloy Plating (91% Lead—9% Tin) *150 Diameters*

When tin is plated out simultaneously with lead from General Chemical Lead and Tin Fluoborate solutions, the lead-tin alloy plate obtained consists of a smooth, even cover in contrast to the grainy surface of the lead plate alone.

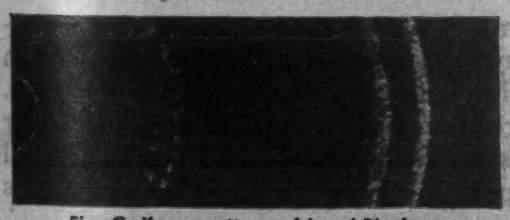

Fig. C: X-ray pattern of Lead Plating

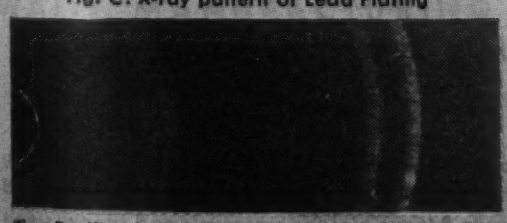

Fig. D: X-ray pattern of Lead-Tin Alloy Plating (91% Lead—9% Tin)

Coarse grain spots in Fig. C coalesce in Fig. D to form more uniform lines, indicating finer grain structure. Only lead lines appear in both patterns since the tin atoms have entered the lead lattice to form an alloy in Fig. D.

For more than 25 years metal finishers have sought a successful means of plating lead-tin alloys in the low tin ranges. "Not feasible . . . inoperable . . . too many variables," read published reports on method after method.

Now—with the new chemical tools of General Chemical Fluorine Research—platers are achieving the "impossible."

Here's how: General Chemical *Lead* and *Tin Fluoborate solutions* are thoroughly compatible. Combined in baths using dual or alloy anodes, they plate out dense, fine-grained lead-tin alloy deposits . . . uniformly . . . simultaneously . . . and *with the tin easily controlled at low ranges!*

Thus, *in one operation* an alloy coating is produced that is harder, more wear-resistant, and has a more attractive appearance than lead plate alone. Little wonder that leaders in the bearing industry are adopting the combination fluoborate bath for lead-tin alloy plating of their products.

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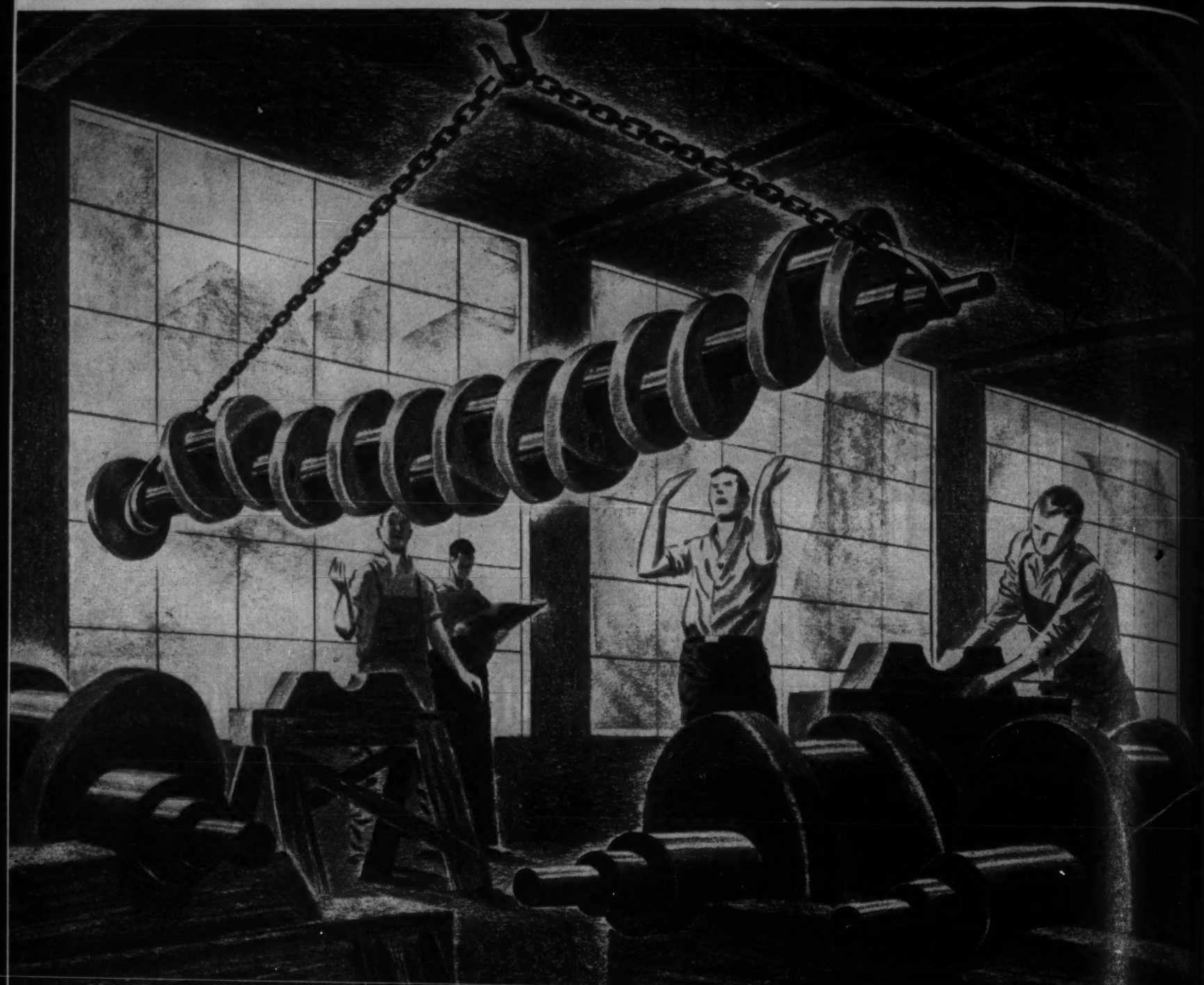

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—"Condition" Castings with Vanadium

As ever larger and more complex castings come from America's foundries, the contributions of Vanadium for improving physical properties and giving better structural control become increasingly apparent.

Vanadium enables both cast steels and cast irons to fulfill better the tasks assigned to them because it increases strength and wear resistance without adversely affecting ductility. Vanadium contributes to both the obvious advantage of simplified heat-treatment and improved physical properties. It toughens steel castings and improves their resistance to fatigue by refining grain size, also toughens cast iron by refining its structure.

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Three grades of Ferro Vanadium are available to meet all needs: *Grade A* (Open Hearth) for general use in Vanadium cast steels and Vanadium cast irons; *Grade B* (Crucible) for tool steels and special steels requiring high percentages of Vanadium in which permissable limits of silicon and carbon are narrow; *Grade C* (Primos) for steels requiring high percentages of Vanadium and extremely low carbon and silicon contents. Additional data and Technical Literature covering composition, use and applications of Ferro Vanadium will be supplied upon request.

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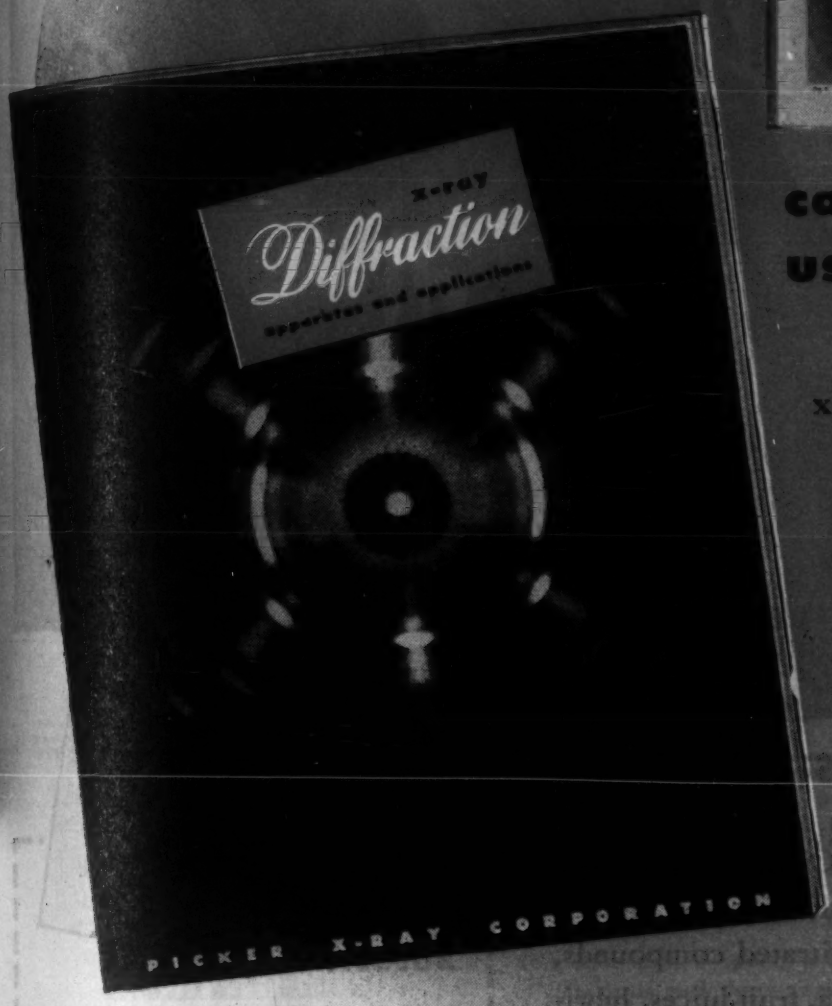
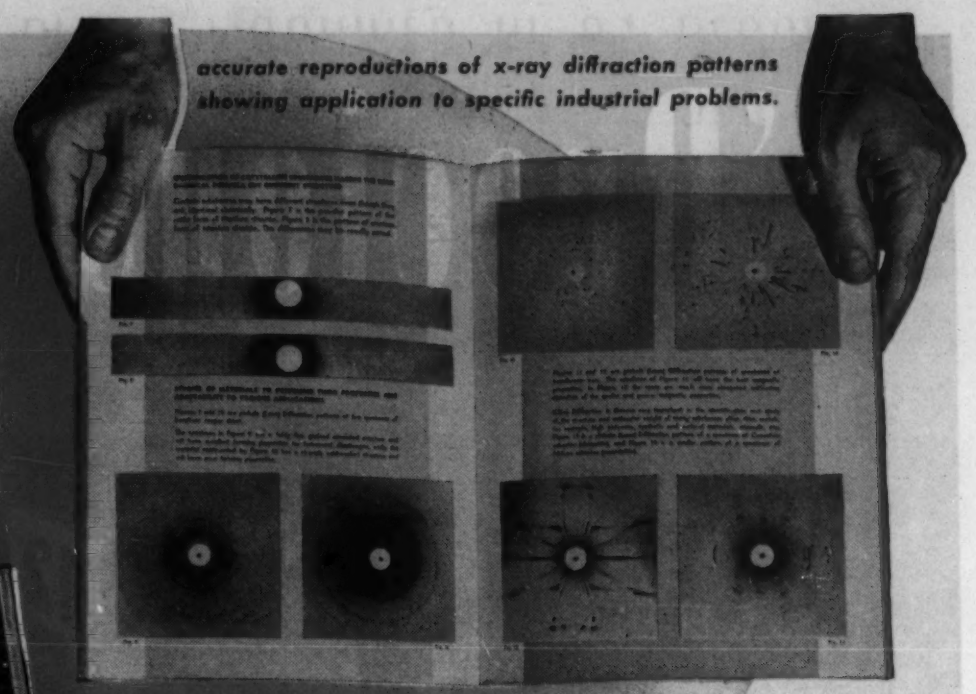




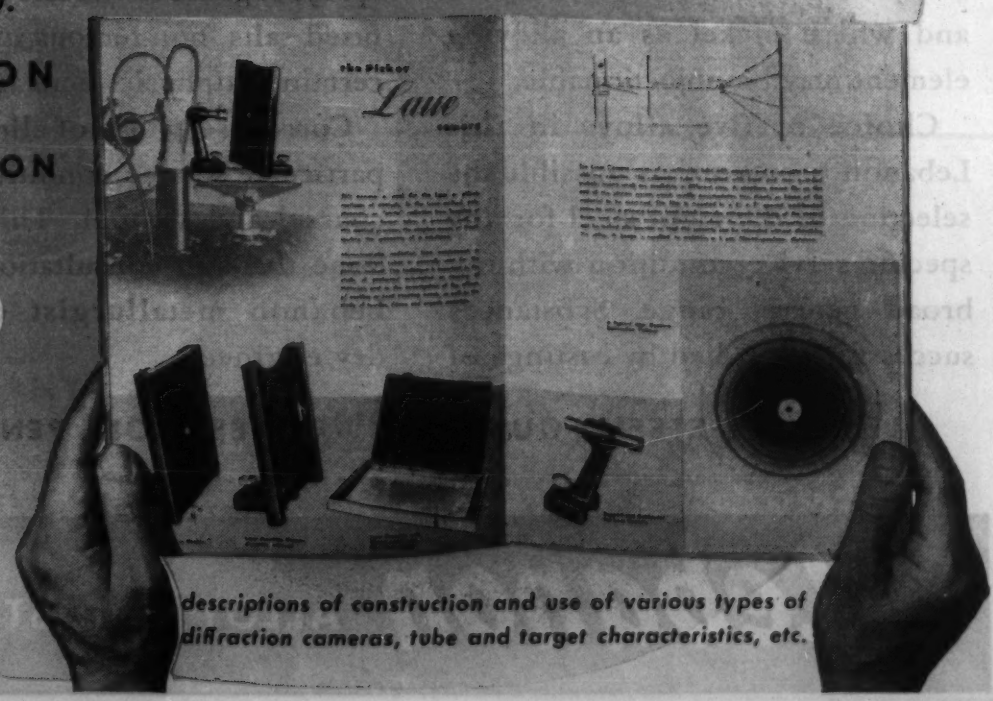
can bring you up-to-date on uses of x-ray diffraction . . .

You've heard of the remarkable contributions x-ray diffraction has made to many urgent wartime problems (in the development of synthetic rubbers, use of steel in shell cases, improvements in plastics, among others). Its applications are so diverse that in many plants today x-ray diffraction has become an indispensable routine tool for rapid physical and chemical determinations, research in product improvement and design, studies in waste reduction. This Picker Bulletin No. 1245, just published, discusses many phases of application, types of apparatus, techniques employed. It will be helpful in the evaluation of the method in your own problems. *Send for it today.*

Picker Bulletin No. 1245 is available without cost or obligation. Simply ask for it (on your letterhead, please, to either of the addresses below).

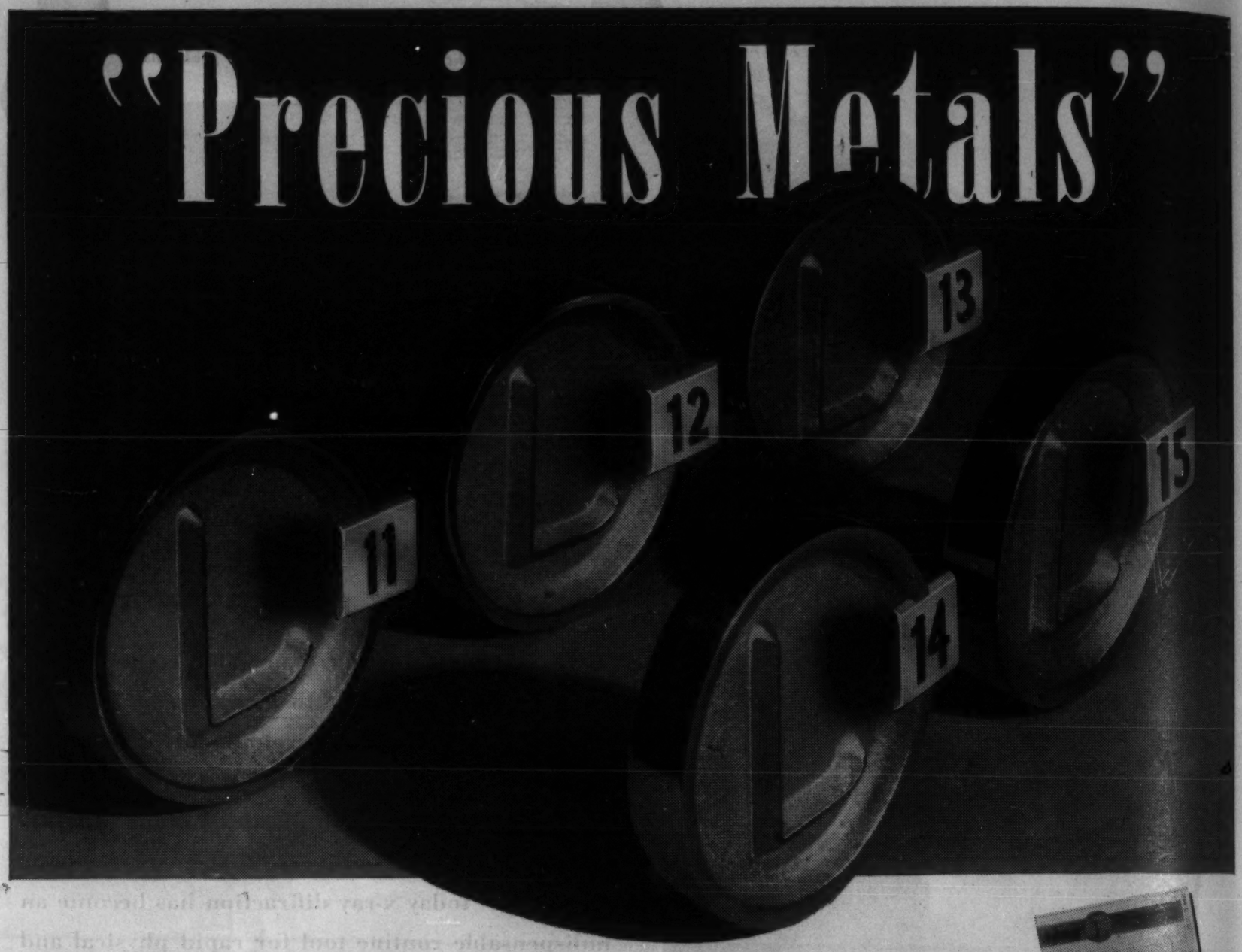
PICKER X-RAY CORPORATION
300 Fourth Avenue, New York 10, N. Y.

WAITE MANUFACTURING DIVISION
17325 Euclid Avenue, Cleveland 12, Ohio



descriptions of construction and use of various types of diffraction cameras, tube and target characteristics, etc.

"Precious Metals"

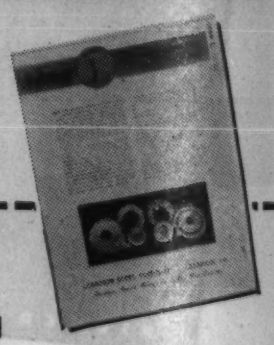


TO USERS OF STRAIGHT CHROMIUM STAINLESS STEEL CASTINGS

LEBANON'S series of straight chromium stainless steels . . . 12% to 30% chromium range . . . are highly valuable wherever their physical, machining and corrosion-resistant characteristics economically meet service conditions . . . and where nickel as an alloying element may be objectionable.

Choice of five alloys in this Lebanon group makes possible the selection of the right steel for any specific service condition within a broad general range. Substances successfully handled by castings of these various Circle (L) straight chromium stainless steels include nitro cellulose, nitrated compounds, alcohol, ammonia, fruit juices, lubricating oils, steam, soap, lye, vegetables, fresh water, vinegar, salt spray, organic chemicals and acids, fused salts, non-ferrous metals and certain sulphuric acid solutions.

Correct selection of alloy for the particular service conditions is, of course, an essential. This is best done through consultation with a Lebanon metallurgist or foundry engineer.



NEW BULLETIN

Describes all five Lebanon Circle (L) Straight Chromium Stainless Steels. Shows Chemical Analyses and Physical Properties at a glance. Write for free copy today.

Lebanon Circle (L) 11. 18% to 20% Chromium; .30 Carbon Maximum

Lebanon Circle (L) 12. 12% to 14% Chromium; .12 Carbon Maximum

Lebanon Circle (L) 13. 12% to 14% Chromium; .25 Carbon Maximum

Lebanon Circle (L) 14. 21.50% Chromium; 1% Copper; .30 Carbon Maximum

Lebanon Circle (L) 15. 26% to 30% Chromium; 1.5% Nickel Maximum; .30 Carbon Maximum

LEBANON STEEL FOUNDRY **LEBANON, PENNA.**

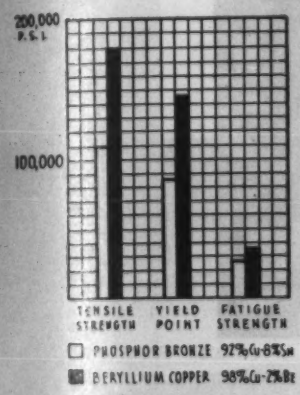
ORIGINAL AMERICAN LICENSEE GEORGE FISCHER (SWISS CHAMOTTE) METHOD

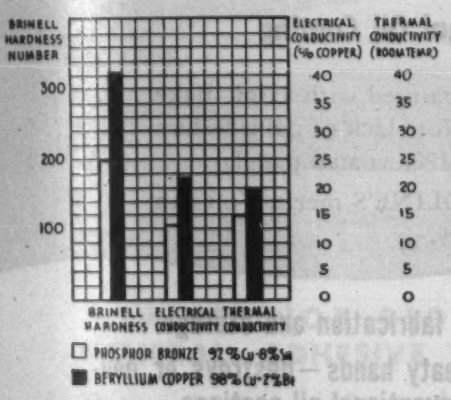
Lebanon ALLOY AND STEEL Castings

BERYLLIUM COPPER SCREW BLANK MACHINED IN 8½ SECONDS

New Britains Boost Vital Production 500% On B-29 Superfortress Engine Part

Beryllium Copper Screws, used as tube connections for the fuel injection system of a B-29 engine, help to accomplish the feats of these modern air battlewagons . . . bringing destruction and devastation to our enemies.





ELECTRICAL CONDUCTIVITY (% COPPER)	THERMAL CONDUCTIVITY (ROOM TEMP.)
40	40
35	35
30	30
25	25
20	20
15	15
10	10
5	5
0	0

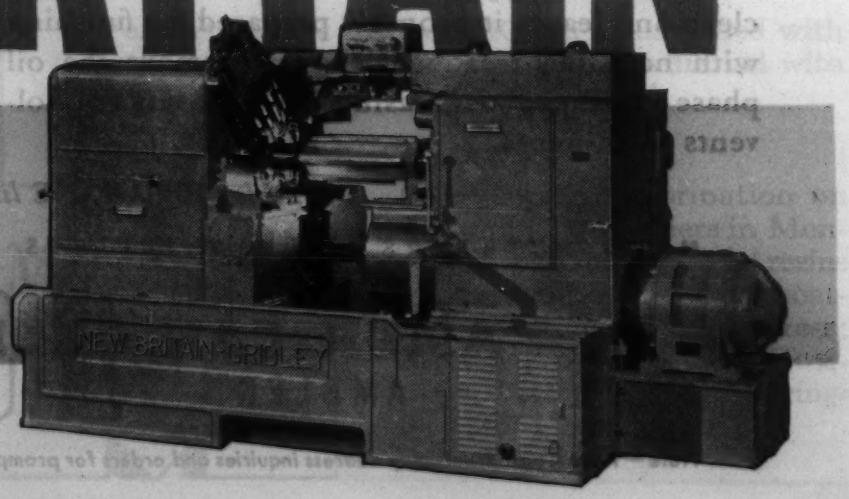
The strategic war metal Beryllium has proved its superiority when combined with copper . . . an alloy possessing the mechanical qualities of strength and hardness of steel plus the conductivity and corrosion resistance of copper. Today's airplanes, tanks, ships, engines, instruments and communications equipment are dependent upon Beryllium Copper parts for superlative performance.

To meet the demands for B-29 bombers, parts manufacturers were called upon to step up production. A small but vital engine screw required forty-two seconds to complete the first operation on an automatic screw machine. New Britain engineering resources were tapped for the answer with the result that a New Britain now completes a finished Beryllium Copper screw blank every eight-and-one-half seconds . . . or 513 pieces gross per hour. The hardness of this alloy is C-18-22 Rockwell and machined at 260 feet per minute with spindle speeds of 1492 R.P.M. Due to the rigidity of New Britain slides, the average life of the carbide tipped tools runs 3500 to 4000 pieces per grind.

This New Britain speed and machining efficiency has not been approached with any other type of automatic and these same practices may readily apply to your present or postwar production. The automatic solution to your metal working problems can be supplied when consulting the New Britain Sales-Engineer in your area . . . or, should you prefer, write direct.

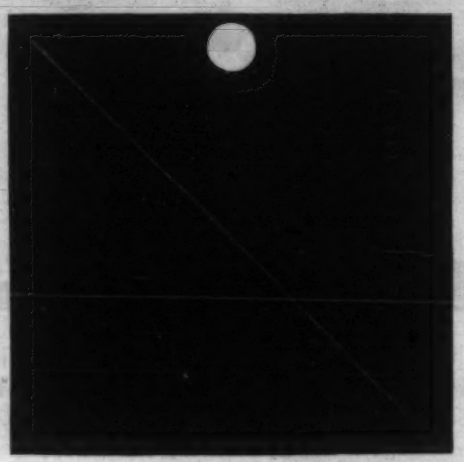
NEW BRITAIN

THE NEW BRITAIN MACHINE COMPANY
NEW BRITAIN, CONNECTICUT
New Britain-Gridley Machine Division

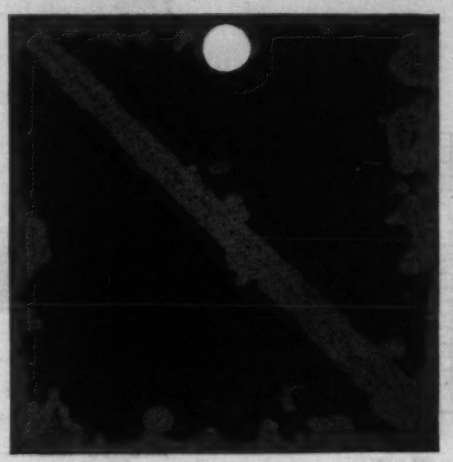


M-01014

Peroline
PREVENTS RUST
PROPERLY CONDITIONS FOR PAINTING



Painted after Peroline Protection



Painted after Conventional Oil Coating

Both of these panels were vapor degreased and painted with High Bake Black Fender Enamel and exposed to Salt Spray. Note lack of paint failure at the diagonal scratch and at the edges of PEROLINE coated panel.

These photographs are positive evidence of PEROLINE'S merit. You can duplicate the demonstration in your own laboratory.

PEROLINE

- **provides better rust protection for parts in transit, fabrication and storage.**
- **removes light blushes of rust and marks from sweaty hands—destroys or neutralizes chemicals that would develop rust under conventional oil coatings.**
- **produces a properly conditioned surface for durable paint finish when the oil phase is removed from the work with solvents or in a vapor degreaser.**
- **makes it possible to safely use a vapor degreaser in preparation for a durable paint finish.**

PEROLINE, if applied to a clean surface, keeps it clean and leaves it properly prepared for finishing with no other treatment than to remove the oil phase by vapor degreasing or with suitable solvents or thinners.

The Technical Department of the American Chemical Paint Company will also gladly advise you regarding proper chemicals for your use in rust removing and metal cleaning both for war products and those for domestic use.

Send for PEROLINE *literature Department G-6.*

MANUFACTURERS OF INHIBITORS AND METAL WORKING CHEMICALS

AMERICAN CHEMICAL PAINT CO.
AMBLER ACP PENNA.

Note—West Coast Plants may address inquiries and orders for prompt delivery to Leon Finch, Ltd., 728 East 59th St., Los Angeles, California.

NOW

JOB TESTED

resin for bonding

PHENOLIC LAMINATES

IMPREGNATED WOOD

PHENOLIC MOLDED PIECES

RESINOX 410

Wing tabs manufactured with Resinox 410 by Hood Rubber Co., Watertown, Mass.

New to many, but tried and proved on many a vital war job, is Monsanto's thermosetting phenolic bonding resin, Resinox 410 . . . now ready for additional assignments.

Its use in making wing tabs and fillets for fighting aircraft, for making oil filters for the B-29, and other critical parts proves the practical value of Resinox 410.

The ease of use with various materials under wide-ranging conditions has shown the material to have:

1. Excellent versatility . . . time, temperatures and pressures are not critical. Skilled labor not required. Resinox 410 bonds cured phenolic laminates, impregnated wood and phenolic moldings equally well.
2. Bond meets high strength requirements, is non-brittle and shows excellent resistance to vibrational stresses.
3. Short curing time . . . 10 to 15 minutes after glue line has reached curing temperatures of 275-350° F.
4. Long assembly life...after application of Resinox 410 final curing may be delayed as much as three months.
5. No high pressures needed . . . simple contact effected through clamps, weights or ordinary presses is sufficient.
6. For certain jobs Resinox 410 can be extended with walnut shell or wood flour and can be diluted with water or mixture of water and alcohol.

HOW RESINOX 410 IS USED FOR GENERAL ADHESIVE APPLICATIONS

1. Both meeting surfaces should be cleaned thoroughly, particularly if any mold lubricants have been used. Although not necessary, a roughened surface is preferred.
2. Brush adhesive onto both meeting surfaces, at a solids content of 40%.
3. Coated surfaces should be allowed to dry for approximately one hour at room temperatures. (At temperatures between 200°-250° F. time can be reduced to about 10-15 minutes.)
4. After drying surfaces may be placed in immediate contact and glued, or they may stand in open or closed assembly for a period of up to 3 months at room temperature.
5. Curing is accomplished by placing the dried, coated surfaces together and applying sufficient pressure to maintain intimate contact. Assembly is then heated to about 300°-350° F. Resinox 410 cures in 10-15 minutes after glue line has reached this temperature.

MONSANTO PLASTICS

SERVING INDUSTRY...WHICH SERVES MANKIND

For complete information on Resinox 410, or others in Monsanto's series of industrial resins for bonding, laminating, coating or impregnating address: MONSANTO CHEMICAL COMPANY, Plastics Division, Springfield 2, Massachusetts.

Haul more cargo without exceeding highway load limits. No radical change in design needed. Just lop off *unnecessary* topside weight by using magnesium . . . and still have all the structural strength required.

There are plenty of places where this can be done in truck bodies. You can use magnesium for side posts and panels, corner castings, toprails, roof bows and roof sheet. You will save considerable dead weight by replacing many of the heavy metal parts.

American Magnesium engineers are old hands at weight saving. They will gladly help you and your bodybuilder employ magnesium to best advantage in cutting off needless pounds.

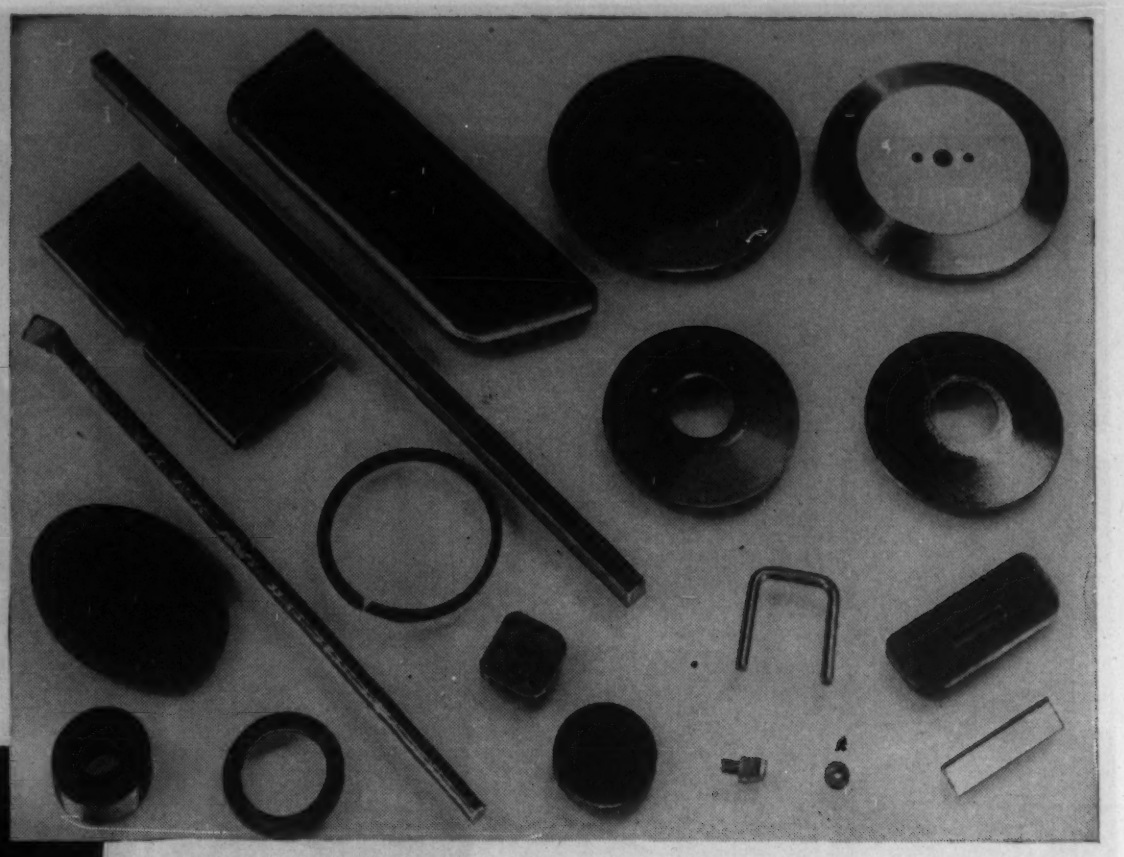
Write Aluminum Company of America, Sales Agents for American Magnesium Products, 1710 Gulf Building, Pittsburgh 19, Pennsylvania.

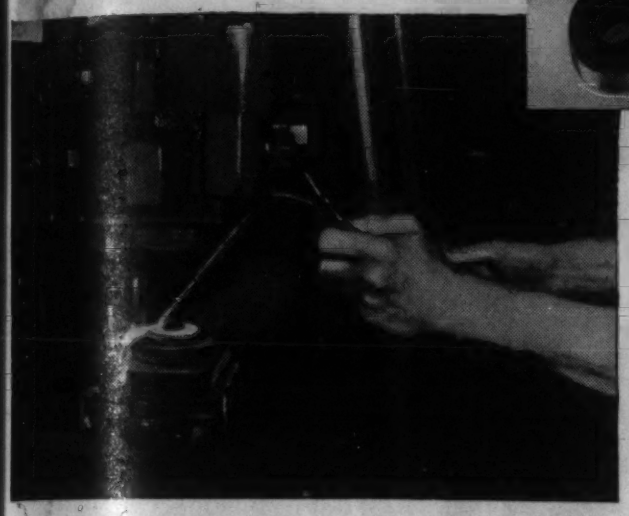
MAGNESIUM MAZLO PRODUCTS

AMERICAN MAGNESIUM CORPORATION

SUBSIDIARY OF ALUMINUM COMPANY OF AMERICA

SEE MALLORY..





..for Special Tungsten and Molybdenum Parts

When you want precision parts of tungsten or molybdenum—metals that are difficult to fabricate—it pays to consult Mallory.

For 28 years, Mallory has successfully produced special precision parts made from tungsten and molybdenum. The combination of modern equipment and experienced workmen enables Mallory to roll, pierce, punch, grind or shape parts with extreme accuracy.

Consult Mallory metallurgists as well, about your needs for precision parts made from other non-ferrous metals. Mallory provides many alloys and powdered metals with unusual mechanical and electrical properties . . . plus the skill, experience and equipment to fabricate them to your specifications. For details write today, to:

Special Products Division

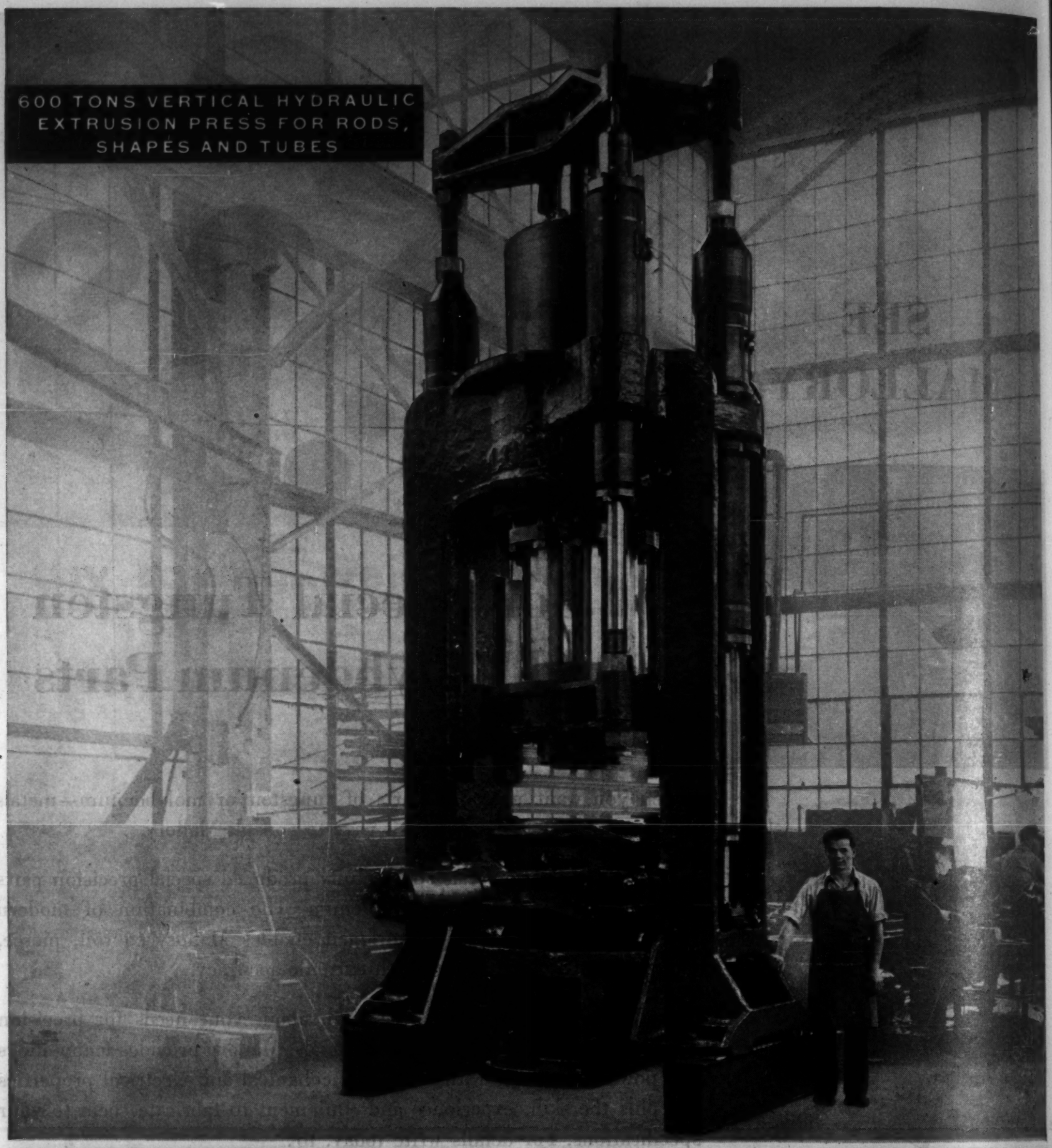
P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

P. R. MALLORY & CO. Inc.

MALLORY

HIGH STRENGTH, HIGH CONDUCTIVITY BRONZE BARS, STRIPS, FORGINGS AND CASTINGS — ELECTRONIC CORES — SPECIAL DEOXIDIZERS AND PURIFIERS — TUNGSTEN AND MOLYBDENUM SHEET, STRIP, ROD AND FABRICATED PARTS — SPARK PLUG ELECTRODES — GLASS "BONDWIRE" — SILVER BI-METAL — RARE METALS

SPECIAL METALLURGICAL PRODUCTS



HYDROPRESS · INC.

ENGINEERS *CONTRACTORS*

HYDRAULIC PRESSES · ROLLING MILLS
STRETCHERS · PUMPS · ACCUMULATORS

570 LEXINGTON AVENUE · NEW YORK · N. Y.

Two Mills.. Supplying "Tailor-Made" Metals

Western mills at East Alton, Ill., and New Haven, Conn., are strategically situated to supply alloy metals to manufacturers throughout the country.

Both of these mills specialize in supplying metals made to rigid requirements. When close tolerances are a "must" we meet the specifications. If your needs call for exacting tempers or finishes they are furnished as ordered.

We will welcome your inquiry regarding "tailor-made" metals . . . in sheet, strip, long coils or stamped parts.

WESTERN BRASS MILLS

DIVISION OF OLIN INDUSTRIES, INC.

East Alton, Illinois

Western BRASS PRODUCTS — WESTERN BRASS MILLS

DIVISION OF OLIN INDUSTRIES INC.

BRASS • BRONZE • PHOSPHOR BRONZE • NICKEL SILVER • COPPER

DON'T TOUCH

IT'S a fine, strong, steel mainspring for a serviceman's watch, but you mustn't touch—not if your fingers are moist with perspiration.

Because, as one war plant discovered, corrosion moves in where the finger has left its mark. Rejections were running high. Production schedules were threatened. And then General Electric Air Conditioning came to the rescue.

Installed in the assembly room, Air Conditioning kept workers' hands cool and dry—winter and summer. Because G-E equipment provides accurate regulation of both temperature and humidity.

Out of our rich and varied experience in helping war industries solve their problems, will come more compact, more efficient, more economical air conditioning and industrial refrigeration after victory. Would you like to be among the first to get all the facts on postwar equipment—when available? Write:

General Electric Company, Air Conditioning and Commercial Refrigeration Divisions, Section 5356, Bloomfield, New Jersey.

GENERAL ELECTRIC

Air Conditioning

BUY and hold WAR BONDS

Tune in: The "G-E HOUSE PARTY" every afternoon Monday through Friday, 4 p. m., E W T, C B S . . . The "G-E ALL-GIRL ORCHESTRA," Sundays, 10 P. M., E W T N B C . . . "THE WORLD TODAY" News, Monday through Friday, 6:45 P. M., E W T, C B S

Have you ever thought of a metal finish this way?

JOHNSON'S INDUSTRIAL WAXES FOR METALS will give your products a selling finish!

When it comes to metal finishes, you may be interested principally in how easily they apply and dry . . . their coverage . . . and other mechanical aspects. But important to you, too, are the better appearance and extra sales appeal these finishes give to products.

Because they protect against corrosion, "shopwear," dirt and finger marks between the time the article is made and sold, Johnson's Industrial Waxes for Metals add "eye" and "buy" appeal. Metal products thus finished stay "new looking" longer. They can be openly displayed without fear of deterioration.

Johnson's Industrial Waxes for Metals are easy and inexpensive to use—they can be applied by the conventional spray, dip, or wipe methods. They have high coverage.

Proved on war equipment, Johnson's Industrial Waxes for Metals can help give new consumer metal merchandise the "plus" it needs to attract and hold the attention of buyers. Get the complete story . . . fill out and mail the coupon today!

A few of the countless METAL PRODUCTS that benefit by Johnson's Industrial Waxes for Metals

Tools of all kinds · Kitchen utensils · Metal stampings
Tin cans · Sporting goods · Nuts, screws, bolts · Padlocks
Builders' hardware · Metal toys · Metal parts

JOHNSON'S INDUSTRIAL WAXES FOR METALS

Made by the makers of Johnson's Wax

S. C. JOHNSON & SON, Inc., Racine, Wis.

S. C. JOHNSON & SON, Inc.
Dept. MA-65, Product Finishes Dept., Racine, Wis.

Gentlemen: I'd like to know how Johnson's Industrial Waxes for Metals can help sell my product. Please send "Special Waxes for Industry" brochure.

Name_____ Title_____

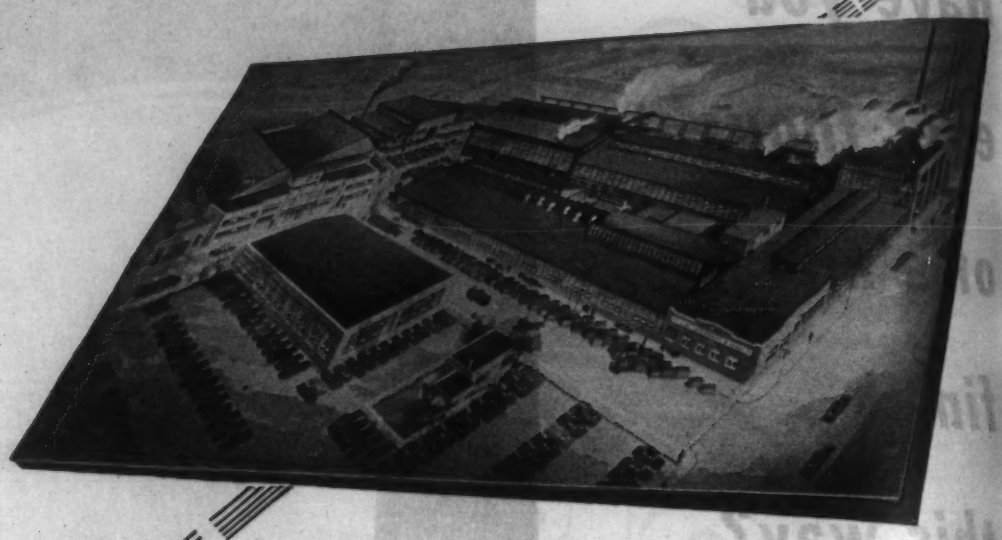
Address_____

Company_____

Product_____

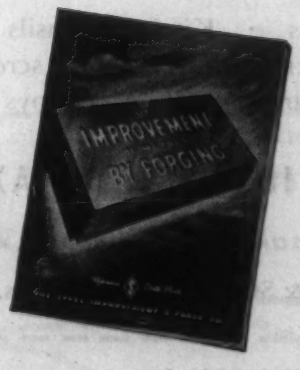
One purpose ...

the IMPROVEMENT of Metals by Forging



Here the most modern forging and heat treating equipment is being utilized, under the direction of highly skilled executives and technicians, to obtain volume production of forgings for the war effort, and to make available for the peace to come high quality forgings for every industrial use.

Steering Knuckle Forging



Reference Data Booklet presents many new ideas on forgings and their applications in many different types of equipment. Copies available to engineers, metallurgists and executives.

Fortify your product with the metal quality developed by forgings. Safety for both men and machines and low-cost performance will be insistently sought by users of your product. A high degree of metal quality in parts subject to stress and shock can be obtained through The IMPROVEMENT OF METALS BY FORGING. Metal quality is inherent in the metal, but employing the correct forging technique develops metal quality fully, and leads to lowest cost per part. Consult a Steel Improvement Forging Engineer backed by 31 years of forging production effort about developing metal quality to meet a specific service condition.

DROP

THE STEEL IMPROVEMENT & FORGE CO.

FORGINGS

956 East 64th Street CLEVELAND, OHIO

TORCH CUTTING WITH PHILLIPS PROPANE

Phillips propane for Torch Cutting is only one of the many applications for which this modern, clean, uniform fuel is used. In fact, Phillips Propane and Butane have the widest possible variety of use throughout industry. Our engineers will gladly assist you in every way possible to help you determine how these natural gases solve the heat application problems in your plant. We invite you to contact our nearest branch office. There's no obligation.

Phillips BUTANE PROPANE

PHILLIPS PETROLEUM COMPANY

Philgas Division

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Branch Offices in NEW YORK, CHICAGO, PHILADELPHIA, MILWAUKEE, DETROIT, ST. LOUIS, SHREVEPORT, AMARILLO, HIBBING, DENVER

THE WORLD'S LARGEST MARKETER OF LIQUEFIED PETROLEUM GAS

"The Impossible TAKES A LITTLE LONGER"

ALUMINUM

This high pressure die casting is typical of those New Products Corporation is making every day. Note the deep, special-shaped groove with thin walls.

MAGNESIUM

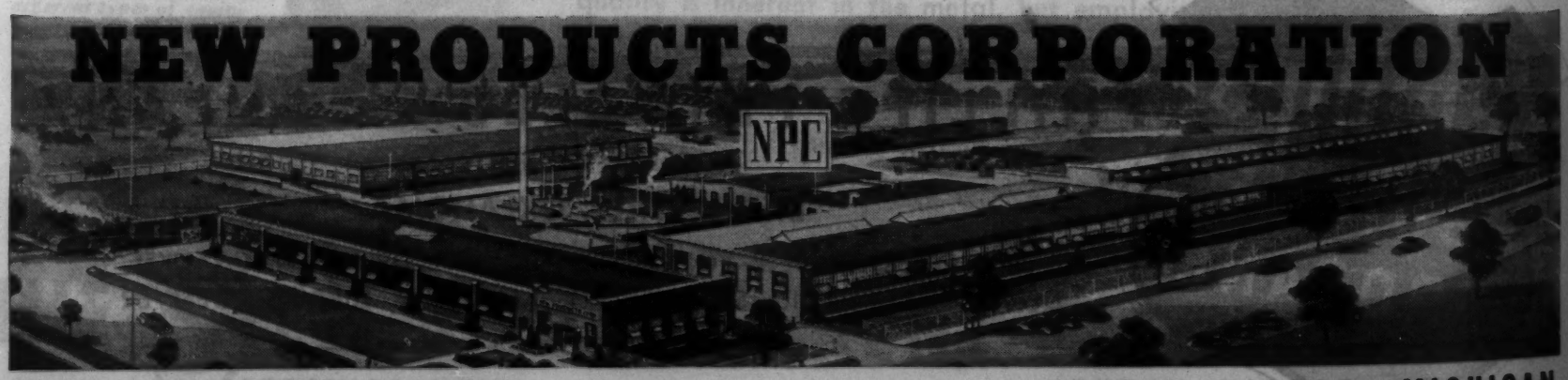
This complicated die casting took that extra engineering skill in order to achieve thin sections over a large area and yet avoid cracks.

HIGH PRESSURE DIE CASTINGS

★ ALUMINUM ★ MAGNESIUM ★ ZINC

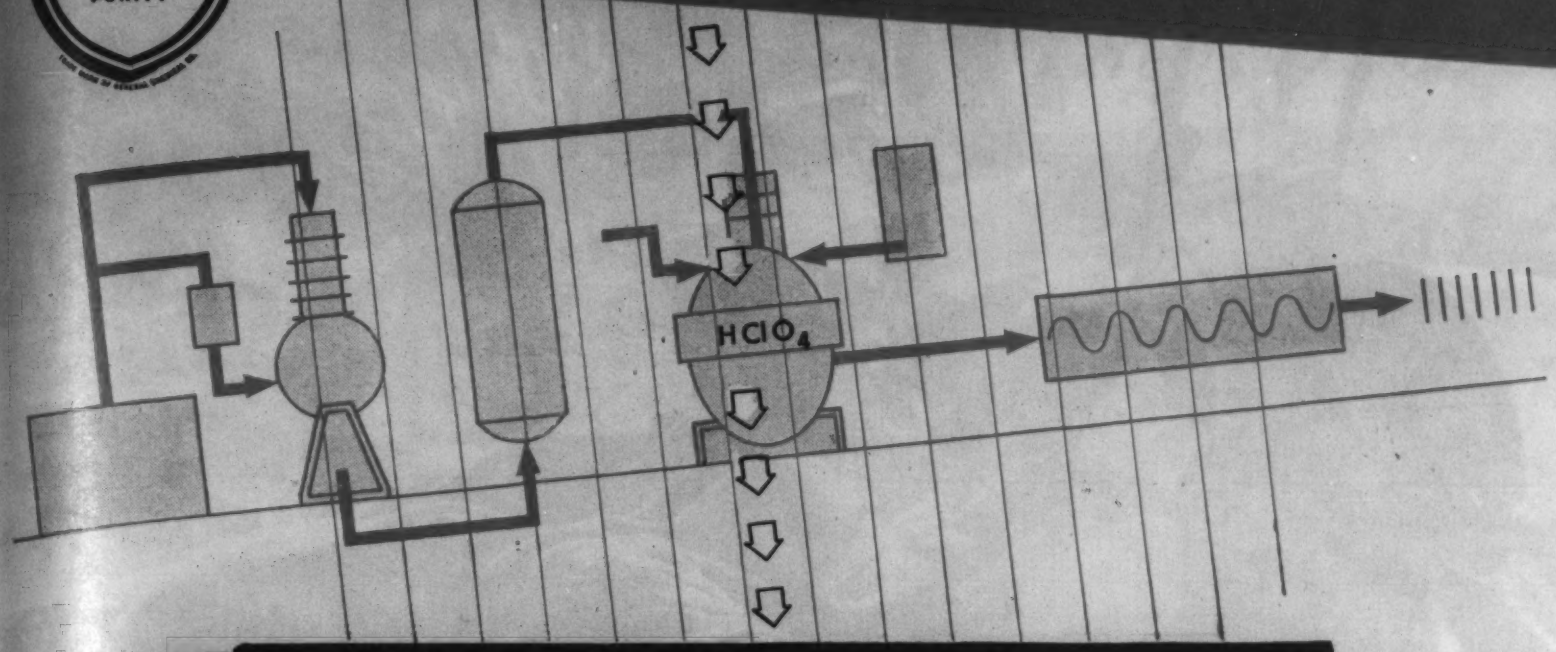
If it's a typical die casting job, New Products Corporation offers experienced, modern techniques for high, scientifically controlled production. If it's complicated, New Products adds to these factors—an engineering "know-how" that gets results. Whether your die casting problems are typical or complicated, the New Products staff is prepared to help you—now or in the future.

NEW PRODUCTS CORPORATION



MAIN OFFICE AND FACTORY — BENTON HARBOR, MICHIGAN

PERCHLORIC ACID, Reagent, A. C. S. 70-72% $HClO_4$



. . . in flow sheets of the future!

NEW and varied industrial roles are being drafted today for B&A Reagent Perchloric Acid, for this "B&A Quality" product has already proved adaptable to the needs of process engineers as well as laboratory chemists.

Whatever your requirements . . . small bottle lots for laboratory applications . . . or carboy shipments by the carload for production use . . . you will find this Baker & Adamson reagent meets *exacting A. C. S. specifications.* Into its making goes all the skill and science B&A has gained in 63 years of "Setting the Pace in Chemical Purity."

Why not investigate the potentialities of this versatile product now? You may find it fills the gap in your process flow sheet as no other chemical will. Specify B&A Code No. 1144.

ACID PERCHLORIC, 70-72%, REAGENT, A. C. S.

$HClO_4$ M. W. 100.47

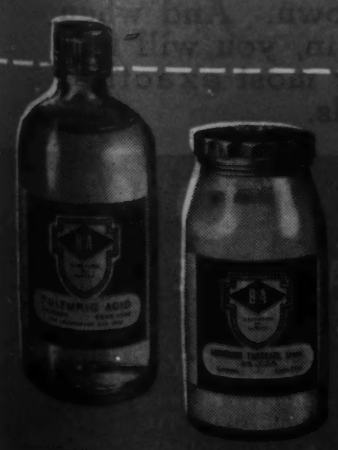
Assay ($HClO_4$) 70-72%

Maximum Limit of Impurities

Nonvolatile	0.003 %
Cl	0.001 %
Total N	0.001 %
NH_3	0.001 %
SO_4	0.001 %
Fe	0.0001%
Heavy Metals (as Pb)	0.0001%
SiO_2	0.001 %

In ¼, 1 or 7 lb. bottles or 70 and 165 lb. carboys
Other strengths also available

Setting the Pace in Chemical Purity Since 1882



BAKER & ADAMSON *Reagent and Fine Chemicals*

Division of GENERAL CHEMICAL COMPANY, 40 Rector St., New York 6, N. Y.

Sales and Technical Service Offices: Atlanta • Baltimore • Boston • Bridgeport (Conn.) • Buffalo • Charlotte (N. C.) • Chicago • Cleveland • Denver • Detroit • Houston • Kansas City • Los Angeles • Minneapolis • New York • Philadelphia • Pittsburgh • Providence (R. I.) • San Francisco • Seattle • St. Louis • Utica (N. Y.) • Wenatchee • Yakima (Wash.)

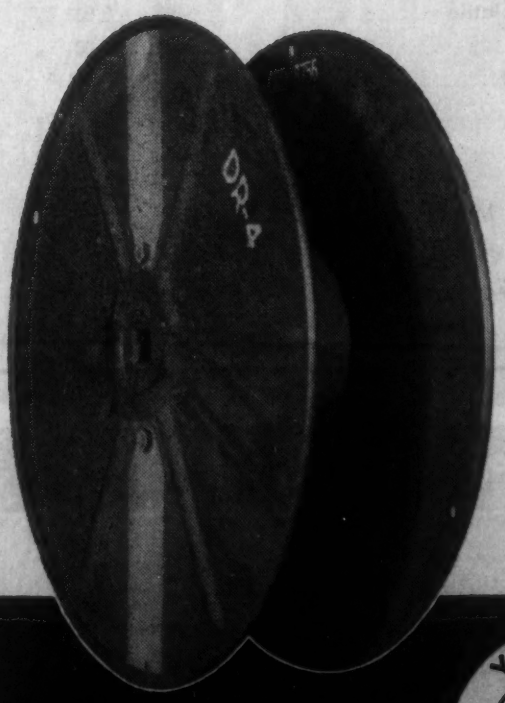
In Wisconsin: General Chemical Wisconsin Corporation, Milwaukee, Wis.

In Canada: The Nichols Chemical Company, Limited • Montreal • Toronto • Vancouver

Yoloy holds the line . . .

Two American Air Commandos asleep beside their reel cart at a newly established airstrip in Burma. Official photo U.S. Air Forces.

As Dawn Breaks in Burma's Jungle



Note in the Yoloy reel above, the hub and spoke shapes pressed in the sides for extra rigidity and the 180° bead flanged around the circumference.

MADE into hundreds of thousands of Signal Corps reels, by Noblitt Sparks Industries, Inc., of Columbus, Indiana, Yoloy helps to establish and maintain communication lines on the battle fronts...in Burma, China, the Philippines, Italy, France, Germany.

This is one of the toughest jobs sheet steel has to do. Reels must be light for easy handling, yet strong enough to stand rough handling and rigidly flat so cable doesn't bind in unwinding. Yoloy--nickel-copper alloy well-known for its strength, shock and corrosion resistance, and deep-drawing qualtities--fills the bill. Wire reels of Yoloy serve America and her allies dependably in jungle, desert and mountains, in rain, sub-zero cold and blistering heat.

Furnishing steel to meet War's toughest demands has become an everyday job for Youngstown. And when you are ready to produce for peace again, you will find us prepared to serve you--to meet your most exacting need, with Yoloy, alloy and carbon steels.

YOLOY YOUNGSTOWN STEEL

YOUNGSTOWN

THE YOUNGSTOWN SHEET AND TUBE COMPANY

YOUNGSTOWN 1, OHIO

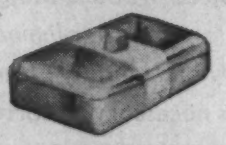
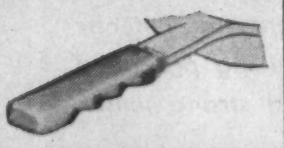
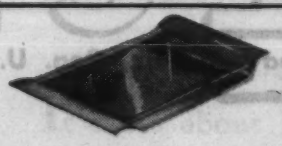
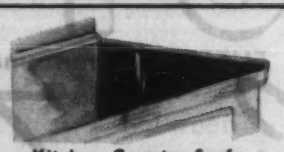
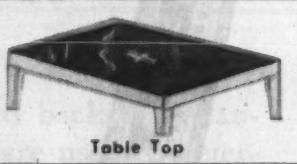
Manufacturers of

CARBON - ALLOY AND YOLOY STEELS

Pipe and Tubular Products - Sheets - Plates - Conduit-Bars-Coke Tin Plate-Electrolytic Tin Plate-Rods-Wire-Nails-Tie Plates and Spikes.

PLASTICS in the *Home Furnishing Field*

OTHER TYPICAL APPLICATIONS

PHENOLIC	Brush Handle	 Cigarette Box	 Utensil Handle	Strainer
THERMOPLASTIC	Coat Hanger	Tool Handle	Desk Accessory	Door Chime Housing
LAMINATED	 Tray	 Kitchen Counter Surface	Chair Seat and Back	 Table Top
UREA	Door Knob	Dishes	Salt and Pepper Shakers	Juice Extractors

To reach a sound conclusion to your problem in plastics consult the skilled technicians—engineers and designers—of the General Electric Company. For advice on the successful application of plastics materials using all available processes of manufacture, write Section H-30, General Electric Company, One Plastics Avenue, Pittsfield, Mass., or call the General Electric Plastics Divisions' office nearest you.

Hear the General Electric radio programs: "The G-E All-girl Orchestra" Sunday 10 P.M. EWT, NBC. "The World Today" news every weekday 6:45 P.M. EWT, CBS. "G-E House Party" every weekday 4:00 P.M. EWT, CBS.

A G-E PLASTICS TECHNICIAN **KNOWS** PLASTICS

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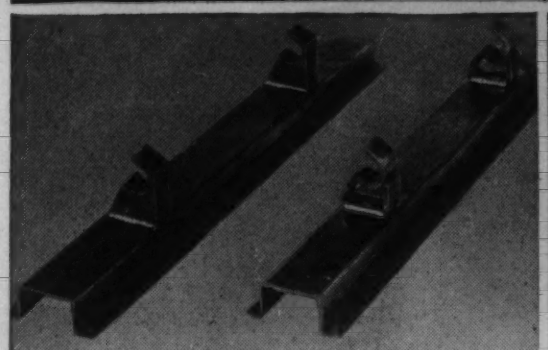
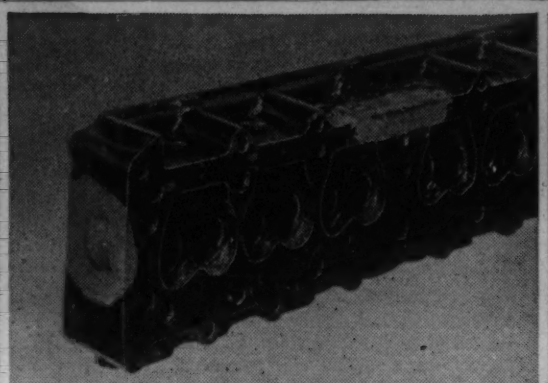
GENERAL ELECTRIC

PD-80

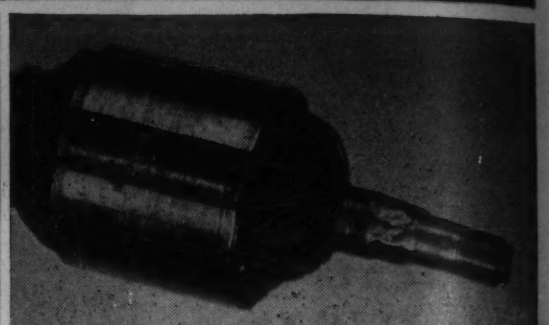
AVOID WELDING DISTORTION STRESSES AND OVERHEATING



Arc welding bombsight hanger on frame member of plane produced severe warping and misalignment. Eutectic Low Temperature Welding prevented distortion and formed strong joints.



Cast iron motor heads are safely repaired without danger of subjecting to stresses, eliminating need for costly and lengthy after machining always necessary to correct distortions.



Worn motor armature shaft resurfaced by Eutectic Low Temperature Welding completely avoiding warping of shaft and preventing destruction of windings by excessive heat.

Every day—there are jobs that can be done *better* the EUTECTIC way. *Try it today!*

WITH EUTECTIC

EUTECTIC (Pronounced U-tec-tic) Reg. U.S. Pat. Off.

Low Temperature WELDING RODS

Bond metals at temperatures as low as 340° F. Reduce heat consumption . . . cut welding costs

Now, without resorting to high temperatures, you can gain the advantage of the strong bonds formed by fusion welding.

The most revolutionary welding development of modern times—EUTECTIC *Low Temperature* Welding enables you to join metals at temperatures below the fusion points of base metals.

Eutectic welding rods and fluxes are available for joining all metals by means of gas—arc—induction—furnace and all standard methods of heating.

Try Eutectic for Production—Salvage and Maintenance welding.

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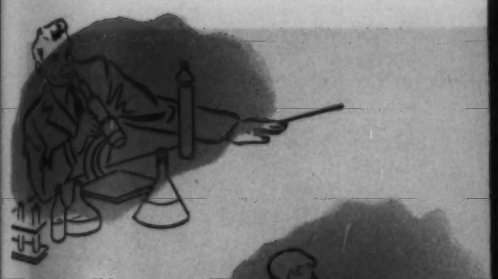
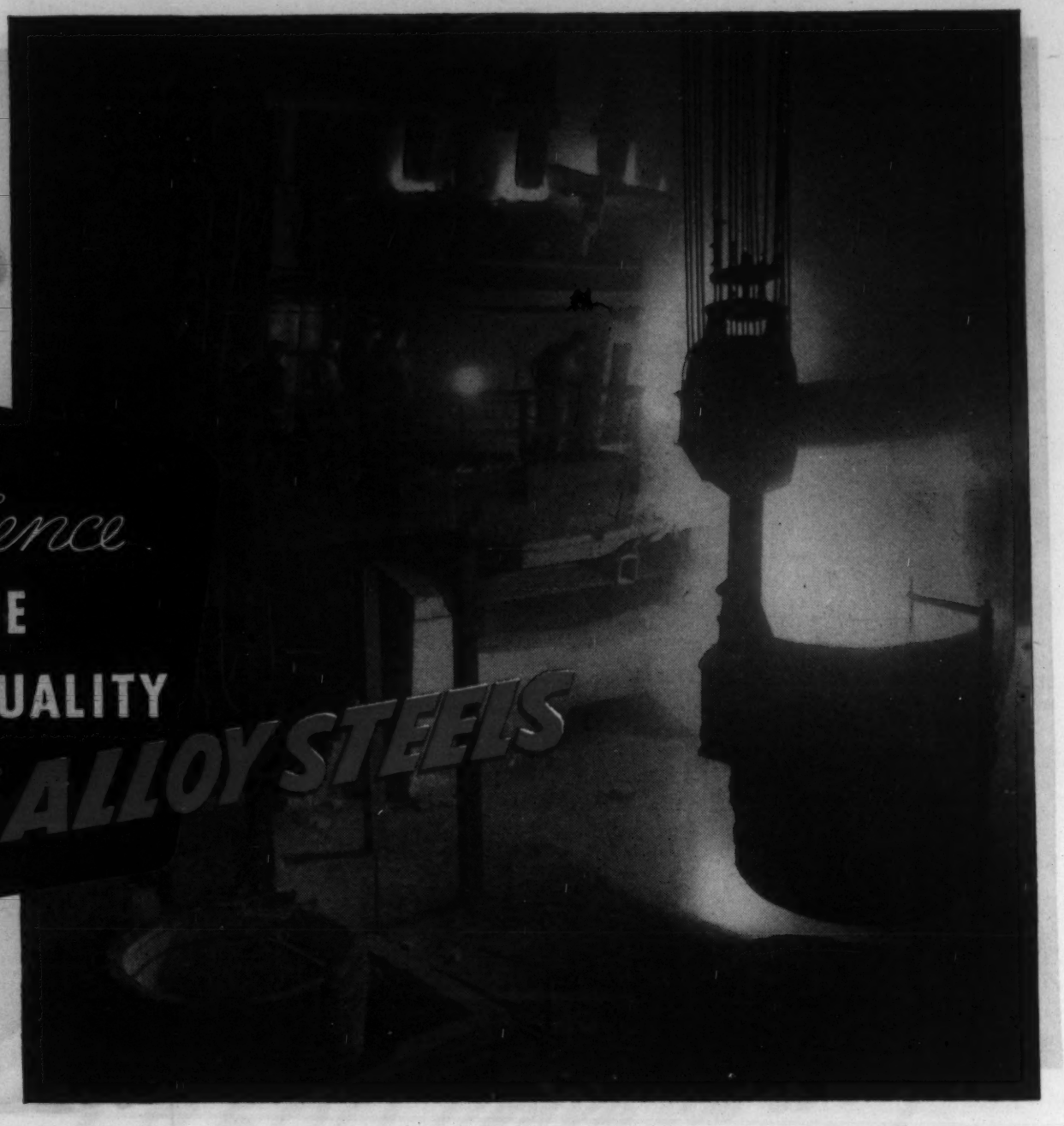
☐ Send me full information for purchasing *introductory assortment* of important Eutecrods for Production Salvage and Maintenance welding.

☐ Please send me The Eutectic Catalog NM 1 containing complete information about Eutectic Low Temperature Welding and its 6 great advantages.

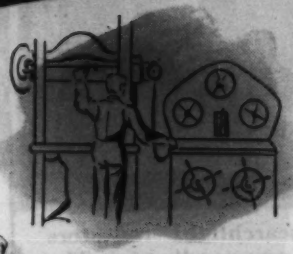
Name_____ Position_____

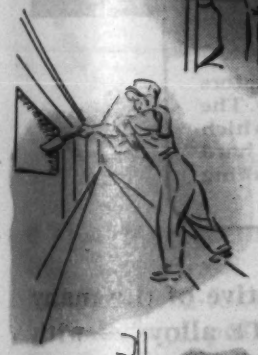
Company_____ Address_____

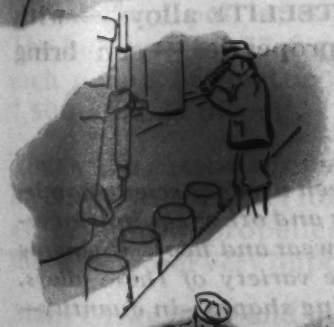




Art and Science CREATE THE UNEXCELLED QUALITY OF TIMKEN ALLOY STEELS







It takes about 11 hours between the time the giant electric or open hearth furnaces are charged until they are tapped, releasing molten . . . white hot Timken Alloy Steel to give strength and quality to the tools of war and victory.

Before and during those hours laboratories and melt shop hum with activity. Scrap is analyzed. Alloys are checked. Good bottoms are maintained by fettling after each heat. Furnaces are skillfully charged to assure exact, uniform melting. Temperatures are carefully controlled. Frequent samples are taken from the furnace. Some are tested immediately in the carbometer, others are whisked to the laboratory for chemical and spectographic analysis. Results, flashed back via telautograph to the melter, are used to determine the alloy additions necessary to maintain the high standard of accuracy set for the chemical composition, grain size, hardenability, physical and mechanical properties of Timken Alloy Steels.

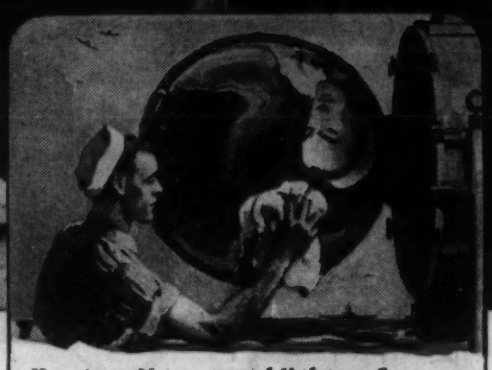
Those precise control measures are your assurance that products made of these fine steels will function satisfactorily . . . even in the most difficult service. If you wish, a member of our technical organization will help you select the Timken Alloy Steel that will most economically meet your needs. Steel and Tube Division, The Timken Roller Bearing Company, Canton 6, Ohio.

Timken Alloy Steels are made in open hearth and electric furnace grades. Regular alloy and stainless steels are available in billets, bar stock and seamless tubes.

TIMKEN

TRADE MARK REG U S PAT OFF

ALLOY STEELS



Keeping Navy searchlight reflectors spotlessly clean is an unending job. The HAYNES STELLITE alloy, from which many reflectors are made, is so hard that constant cleaning and polishing will not mar its surface.

LIGHT ON THE RISING SUN

UNCLE SAM'S NAVY has the most efficient searchlights on the Seven Seas. They are so powerful that one of them measuring 24 inches across can shoot a beam of light through 23 miles of inky darkness.

The reflectors of these searchlights are made of an alloy perfected and produced by HAYNES STELLITE COMPANY.

The Navy is using HAYNES STELLITE alloy for several reasons. It will not shatter from shock of gunfire. It has high resistance to corrosion by salt air, salt spray, powder and sulfur fumes. It withstands the terrific heat of the arc light—and hot particles of copper and carbon from the electrodes do not cause it to pit and lose its reflectivity. Searchlight reflectors are indicative of the many applications to which HAYNES STELLITE alloys — with their unique combinations of properties — can bring more efficient performance.

•

HAYNES STELLITE alloys have long been used for scientific mirrors, surgical and dental instruments and other equipment requiring great resistance to corrosion, wear and heat. Unending research is constantly adding to the variety of these alloys. They can be produced in many exacting shapes—in quantity—and delivered ready for assembly without further finishing.

A booklet describing the properties of Haynes Stellite alloys is available on request.

BUY UNITED STATES WAR BONDS AND STAMPS

HAYNES STELLITE TRADE-MARK

HAYNES STELLITE COMPANY

Unit of Union Carbide and Carbon Corporation

General Office and Works UCC Kokomo, Indiana

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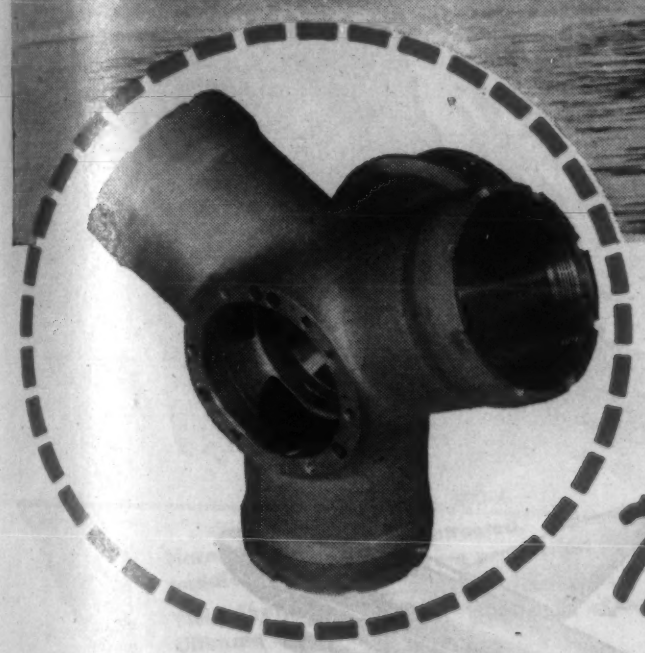
ARMY E NAVY

ABRASION- AND CORROSION-RESISTANT ALLOYS

"HAYNES STELLITE" is a registered trade-mark of Haynes Stellite Company.



Where one pound of steel holds 7,500 times its weight

● That may seem fantastic—but it's true. The strain imposed upon the hub of a 16½-foot, 3-blade propeller by centrifugal pull is 582,000 pounds. The hub weighs 77.6 pounds. Thus each pound of steel in it must hold 7,500 pounds of pull.

That's one reason for using Republic Electric Furnace Steel for hubs as well as for hollow propeller blades. But there's another very important reason.

Many costly man- and machine-hours are consumed by the 37 operations required to machine a 381-pound forging down to the hub shown above. Suppose a small imperfection in the steel should cause rejection at final inspection. All that time and costly work would be wasted—and many dollars lost.

Republic Electric Furnace Steels are the best insurance you can buy against such losses. These outstanding steels are as CLEAN and SOUND as steel can be made.

They are consistently UNIFORM—in physical, chemical, hardenability and performance values — because they are "targeted" to hit product and processing specifications on the nose repeatedly. This can be achieved only in electric furnace melting.

If you employ mass production methods of manufacture, Republic Electric Furnace Steels can help you obtain maximum results—because of their homogeneity and their freedom from practice-upsetting variables.

And, too, these fine steels may be just what you will need to increase the salability of your products. Right NOW is the time to find out. And Republic — world leader in electric furnace steels — is ready to work with you.

REPUBLIC STEEL CORPORATION
Alloy Steel Division • Massillon, Ohio
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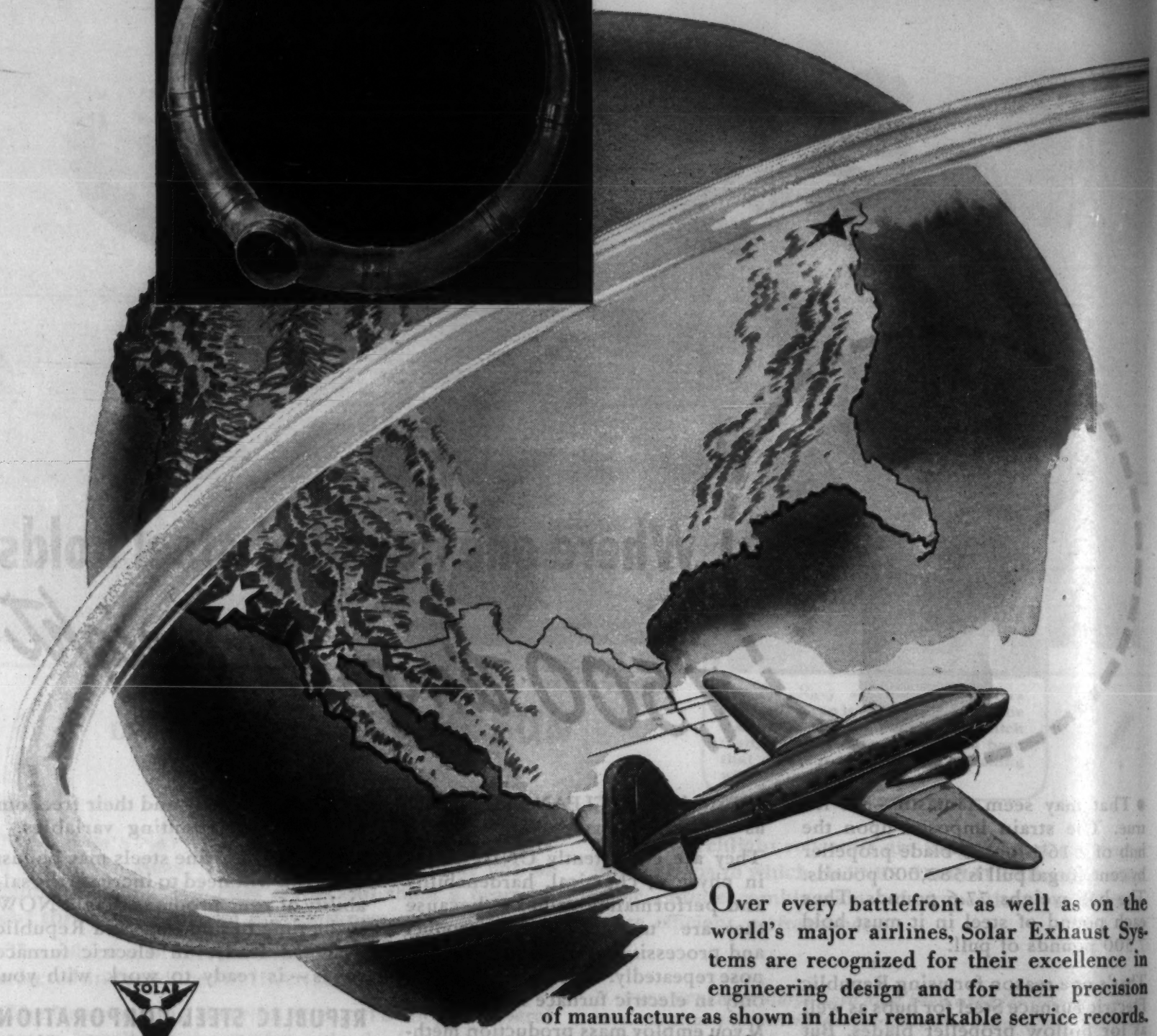
REPUBLIC
—Leader in the Production of
ELECTRIC FURNACE STEELS
"QUALITY" steels . . . alloy . . . stainless

1¾ Million Miles in 3 Years! *Equivalent to*

640 flights New York to Los Angeles logged by a Solar Manifold on American Airlines Flagships



Over every battlefront as well as on the world's major airlines, Solar Exhaust Systems are recognized for their excellence in engineering design and for their precision of manufacture as shown in their remarkable service records.

Typical is the Solar exhaust manifold which American Airlines has had in service for over three years on one of their Wright G-102 engines in their Douglas (DC-3) Flagships. Through all weather conditions, this Solar manifold, in the hands of American's expert maintenance crew, has given more than 10,000 hours of notable service.

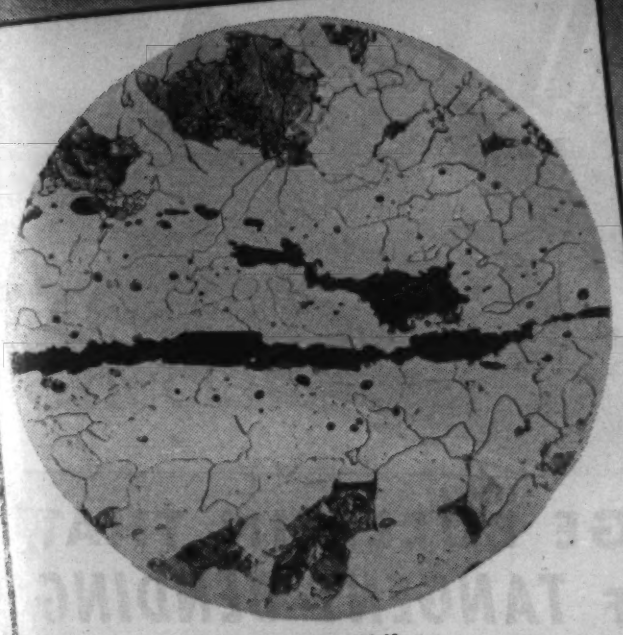
Solar skills will continue to solve problems in the elimination of hot gases, together with the utilization of waste heat energy, the control and transfer of heat and the production of products of high corrosion resistance.

SOLAR

STAINLESS STEEL PRODUCTS

SOLAR AIRCRAFT COMPANY SAN DIEGO 12, CALIF. DES MOINES 5, IA.

"FERROCARBO"-S
assures thorough deoxidation



MAG. 500-X

Normal killed steel, untreated. Transverse tests, middle of ingot, taken from production cycle.

Yield Strength	57,700	Elongation in 2"	.70
Ultimate Strength	62.200	Reduction of area	1.2

MAG. 500-X

Same steel, "FERROCARBO"—S treated. Transverse tests, middle of ingot, taken from production cycle.

Yield Strength	60,000	Elongation in 2"	17.5
Ultimate Strength	81,500	Reduction of area	32.6

Thorough deoxidation — with striking effect on inclusion reduction and dispersion—results from using "FERROCARBO"—S.

Its effective improvement in steel quality is demonstrated beyond question by photomicrographs, stepdown tests, macro etch tests, and Baumann sulphur prints. Magnaflux tests, too, provide conclusive proof of this marked improvement in steel quality.

Compare the accompanying photomicrographs of SAE Forging Steel 1035... made with and without "FERROCARBO"—S. Note particularly the uniformity of structure and absence of ghost lines in the "FERROCARBO"—S treated steel. Comparative physical constants complete the story and offer further proof that "FERROCARBO"—S gives better steel.

This one material . . . used as a ladle addition . . . not only assures thorough deoxidation, but also provides these other important benefits: **Inclusions reduced—uniformly distributed—stringers eliminated; prolonged increase in fluidity; in fine-grained steel—inclusions reduced and dispersed; added ductility.** Moreover, under controlled conditions, an increase in hardenability can be effected to a considerable degree.

Let our metallurgists show how you can use "FERROCARBO"—S. Write The Carborundum Company, Refractories Division, Dept. O4, Perth Amboy, N. J.

"CARBORUNDUM" and "FERROCARBO" are registered trade marks of, and indicate manufacture by, The Carborundum Company.

"Ferrocarbo" distributors are:

KERCHNER, MARSHALL & COMPANY, Pittsburgh, Cleveland and Birmingham.

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Ferrocarbo by CARBORUNDUM
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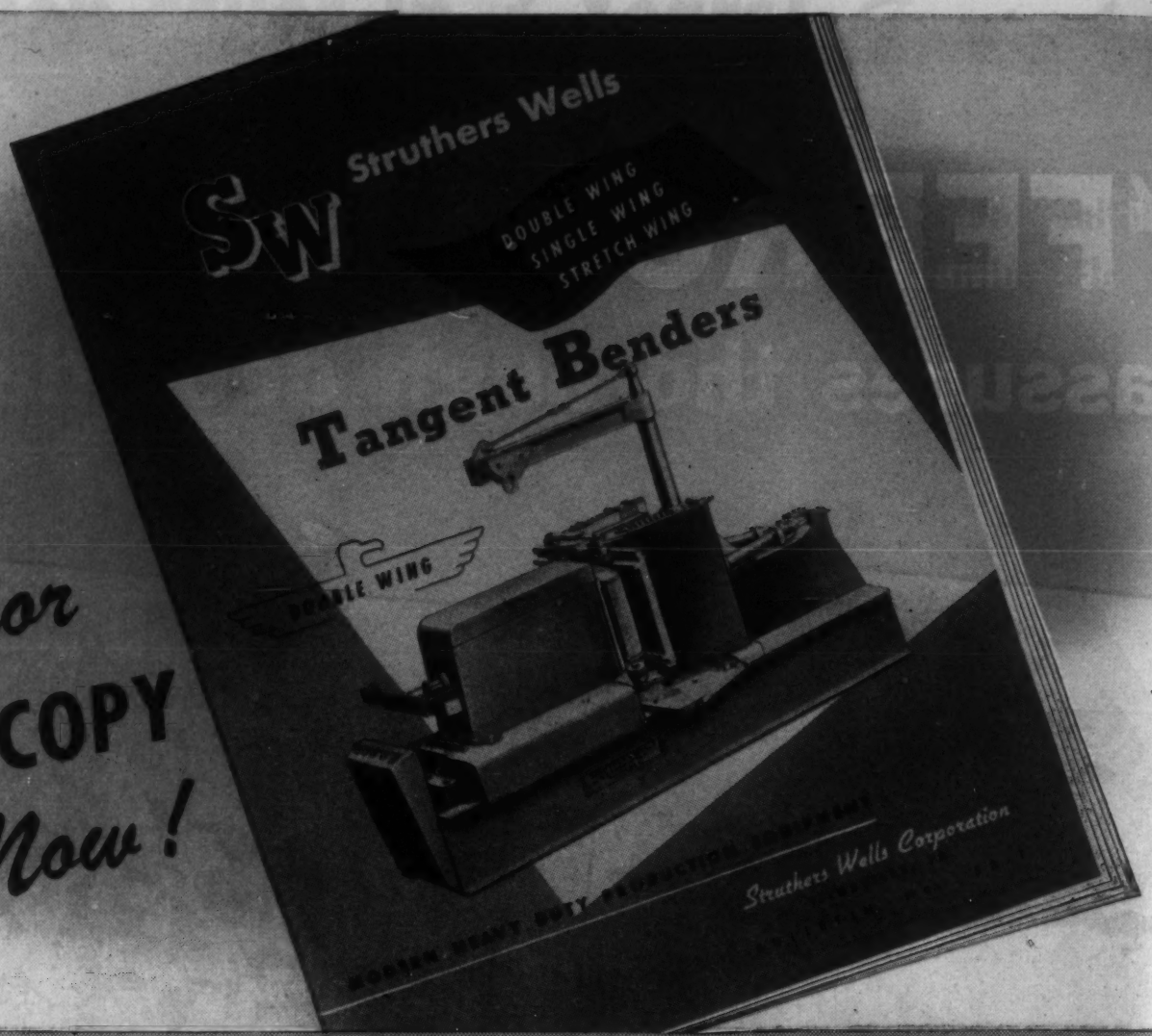

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HERE IS THE NEW 16-PAGE BULLETIN THAT COVERS EVERY PHASE OF *TANGENT BENDING*

Completely filled from cover to cover with important engineering data, product designs, specifications and other vital information.

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SPECIALTIES DIVISION
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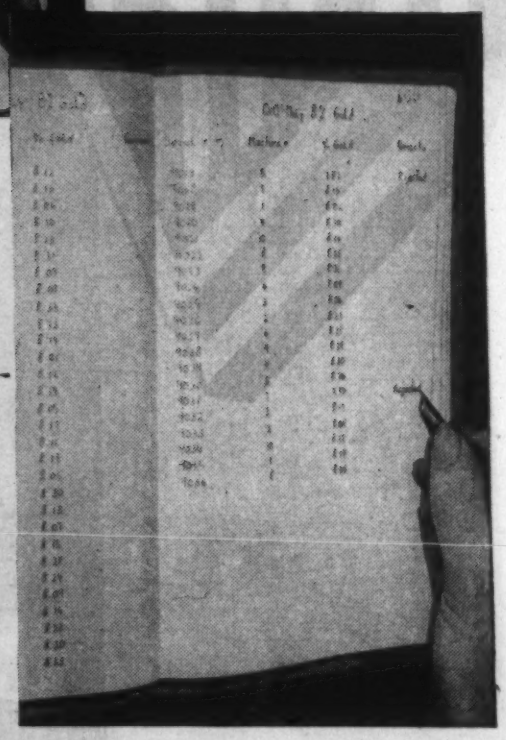
PLANTS AT TITUSVILLE AND WARREN, PA.
Offices in Principal Cities

Preparing a unit sample of fine wire for checking percentage of gold by weight of base metal. This chemical operation removes the wire core. Each spool is tested and recorded in test book (see below).



Checking Amount of Gold on Clad Wire

The superior quality of NORELCO gold-clad fine wire is the result of closely-controlled processing techniques and rigid tests that insure precise adherence to all customers' specifications.

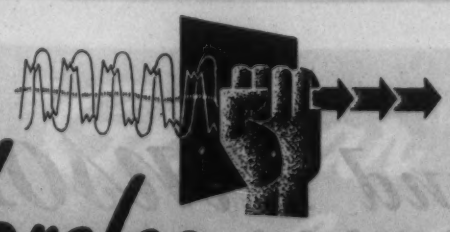
As an example, the special cladding equipment designed by our engineers can coat fine wire with percentages of gold by weight ranging from 0.1% to heavy layers with great accuracy. Where tolerances are not specified, the gold coating is made slightly in excess of the percentage called for.

To make sure that tolerances are being maintained, a specimen from each spool is tested for its gold percentage. A unit sample is chemically treated to dissolve the base metal, and the remaining gold weighed on precision scales.

North American Philips manufactures gold-clad fine wire up to .010" diameter in base metals of silver, tungsten, molybdenum and radio alloys. We also manufacture fine wire below .003" in silver, copper, nickel-chrome, aluminum alloy and other metal alloys. Radio tube manufacturers have found our unusual skill of great value in helping them meet wartime production schedules and reduce material shrinkage. North American Philips has the knowledge of processes and techniques developed by an organization with a background of over half a century in the electrical field. Call on our specialized engineering service whenever you have a fine-wire problem.

OTHER PRODUCTS: In addition to fine wire and diamond dies for our own drawing, we make: Tungsten and Molybdenum products; Quartz Oscillator Plates; Amplifier, Transmitting, Rectifier and Cathode Ray Tubes; Searchray (Industrial X-ray) Equipment; X-ray Diffraction Apparatus; Medical X-ray Equipment, Tubes and Accessories. We invite you to visit our office and showroom when in New York City.

Where NORELCO Fine Wires Are Used in the Electronics Field — Precision wire-wound resistors; hearing aids; radio head phones; sensitive recording and indicating meters; sensitive relays; electronic tube grids and filaments; fractional horsepower motors and hundreds of other uses wherever fine wire is required.



Send for NORELCO Fine Wire Booklet on your letterhead. It contains valuable conversion tables for ready reference of buyers and design engineers.

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NORTH AMERICAN PHILIPS COMPANY, INC.

Executive Offices: 100 East 42nd Street, New York 17, N. Y.
Factories in Dobbs Ferry, N. Y.; Mount Vernon, N. Y. (Metalix Division); Lewiston, Maine (Elmet Division)

North American Philips Company, Inc.
100 East 42nd Street, New York 17, N. Y.

Gentlemen:

Please send me a copy of your booklet "Norelco Fine Wire."

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Title_____

Company_____

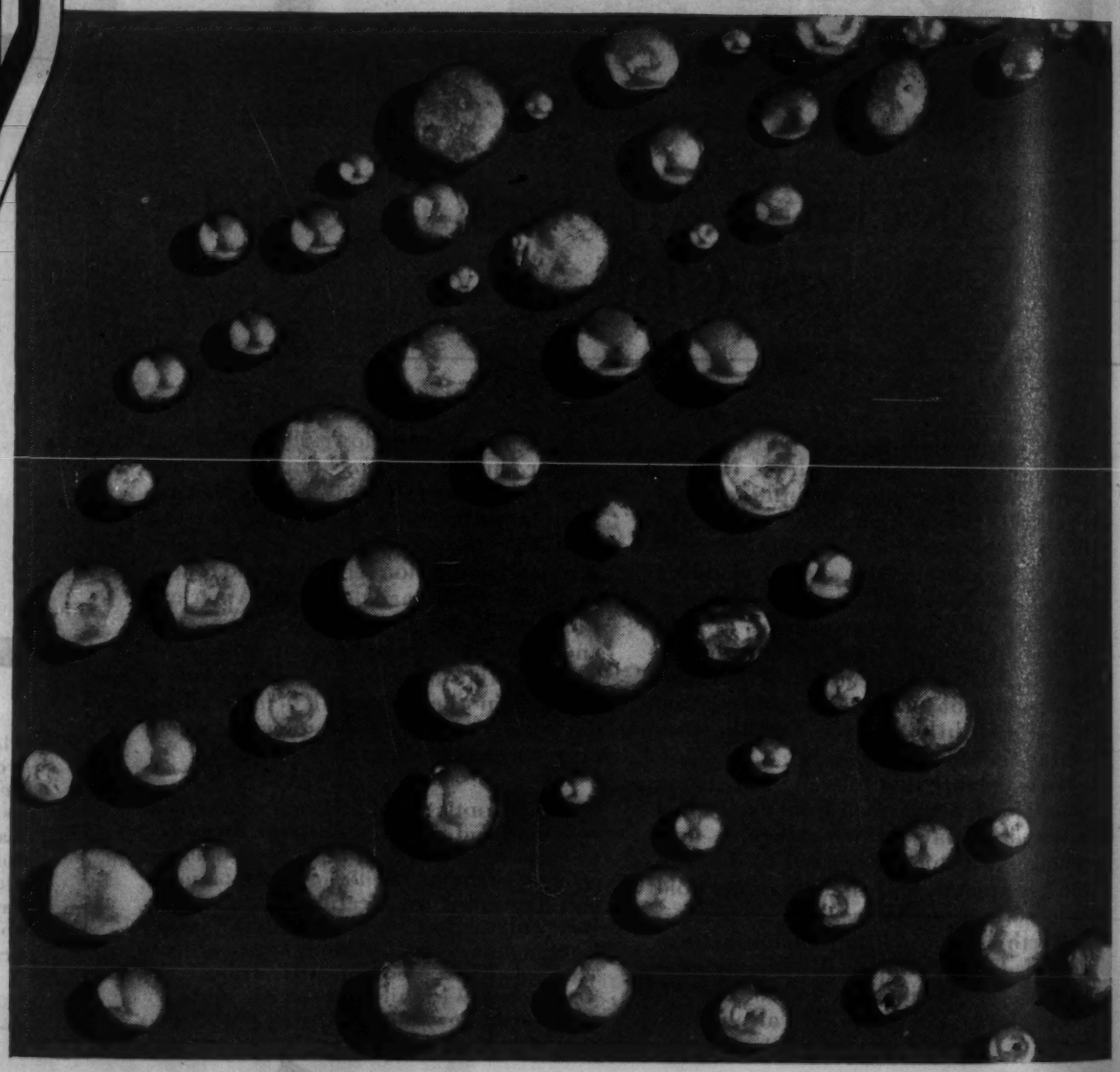
Address_____

Dept. U-6

ALLOYS

SPI

NICKEL COPPER SHOT



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"Harder Cutting Edges!"

"Furnaces pay for themselves fast!"

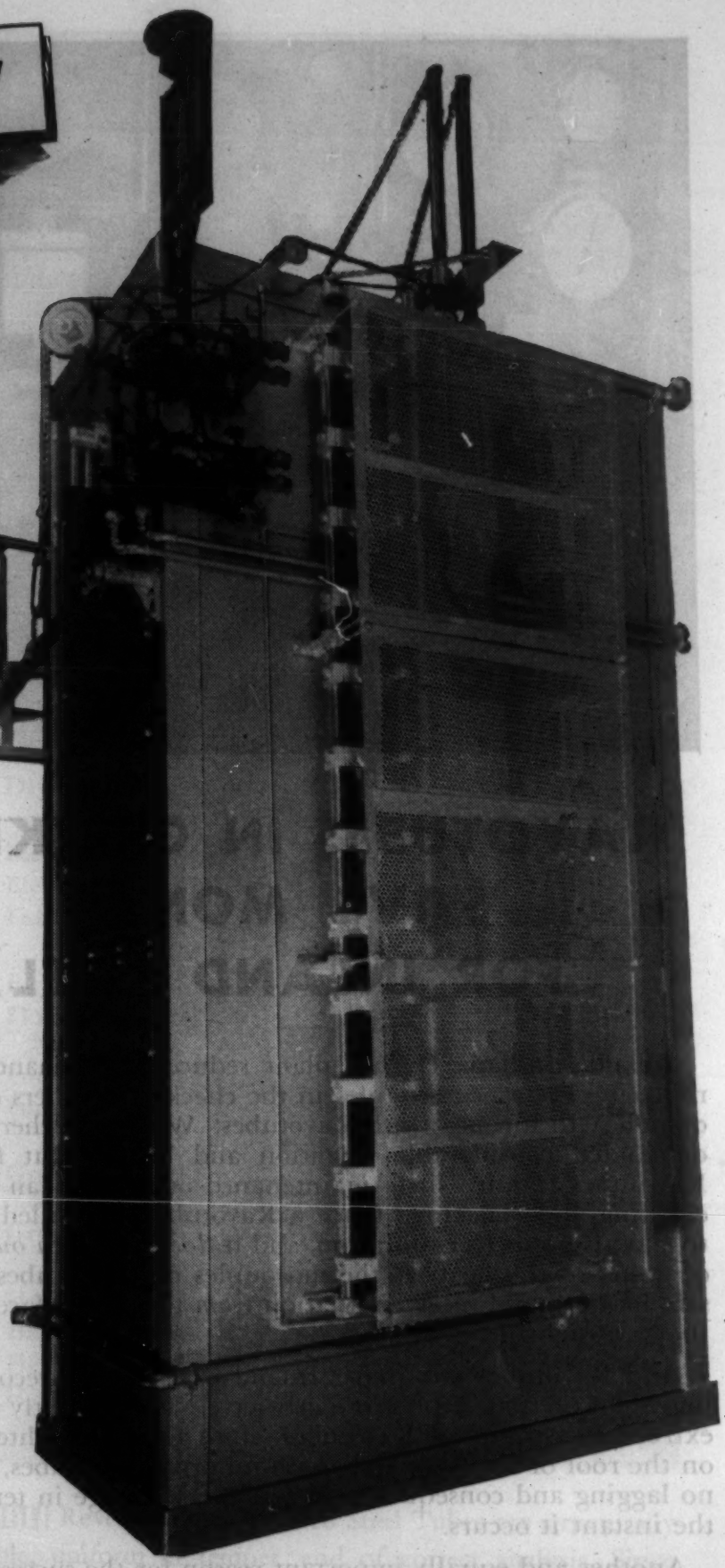
"Rejects due to faulty hardening eliminated!"

"Production increased up to 50%!"

"Greater Uniformity!"

THAT'S what users say of this high speed steel heat treating furnace equipped with "GLOBAR" Electric Heating Elements! Made by the C. I. Hayes, Inc., and used for hardening high speed steel broaches and other types of tools of unusual length, it demonstrates once again the versatility of these superior non-metallic heating elements.

"GLOBAR" Electric Heating Elements guarantee continuous operation of the furnace because they are as simple to install as a cartridge fuse. They require very little attention and provide clean uncontaminated heat, unvarying in quality and quantity. We would be glad to put you in touch with users of these furnaces. You could not ask for better recommendation. Write direct to The Carborundum Company, Globar Division, Niagara Falls, New York.



The chamber is 80" deep and has two charging openings at the top, each 12" x 12", which are foot-operated. The furnace is divided into three zones with separate temperature control in each. Furthermore, temperature is uniformly controlled throughout the furnace and atmospheres are closely regulated to insure uniform grain structure in the steel.

"Globar" Heating Elements by CARBORUNDUM

TRADE MARK

("CARBORUNDUM" and "GLOBAR" are registered trade marks of and indicate manufacture by The Carborundum Company)

V depends on me!
A Slogan For Every American

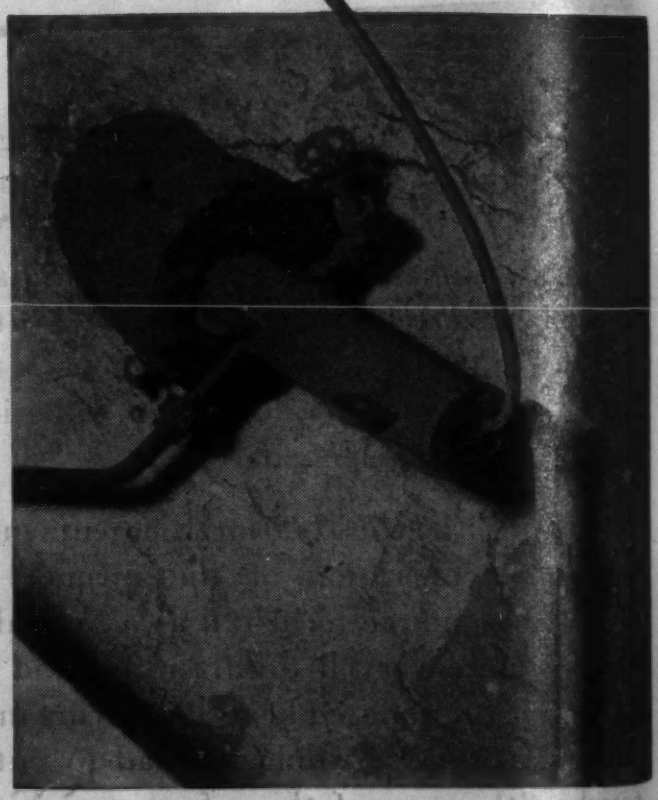
RAYOTUBES IN CHECKERS SAVE MONEY FOR INLAND STEEL

Inland's Indiana Harbor plant reduces maintenance costs by replacing the thermocouples in the checker chambers of their 36 open-hearth furnaces with Rayotubes. Where the thermocouples demanded considerable attention and burned out frequently, Rayotubes require little maintenance other than an occasional cleaning and checking. Once a Rayotube is installed, it's there to stay; it holds its calibration, and it *does not burn out*. Instead of going *to* the heat, as thermocouples do, Rayotubes stay in a safe location and receive radiation *from* the hot surface on which they are sighting.

And Rayotubes are giving Inland much better recorder readings than thermocouples formerly gave. This is partly due to the extreme sensitivity of Rayotubes; since they are sighted directly on the roof of the neck arch, with no protection tubes, they have no lagging and consequently detect every change in temperature the instant it occurs.

Another and equally important reason for the success of Rayotubes in this plant is that they measure temperature at a location which is too hot for couples. By thus working nearer the maximum, they assist the First Helper in avoiding refractory damage.

Our engineers will be glad to make specific recommendations for use of Rayotubes, or they will send Catalog N-33B, as you prefer.



This Rayotube at Inland Steel Co., Chicago, is mounted in the checker chamber wall of an open-hearth furnace. It receives radiation and reports temperature to the Micromax Recorder (see arrow) by means of the lead-wire, just as a thermocouple would do.

LEEDS & NORTHRUP COMPANY, 4925 STENTON AVE., PHILA., PA.

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The uses of REVERE WELDED STEEL TUBE are endless

REVERE Welded Steel Tube can be had either in straight lengths, or partly or completely pre-fabricated. Our tube-working equipment is highly specialized, and customers frequently find that it effects appreciable savings in costs.

- A — Agricultural Implements; Air Compressors; Air Conditioning Equipment; Aircraft Parts; Automotive Parts
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- C — Condensers; Conveyor Rolls
- D — Display Stands; Drying Machines
- E — Electrical Equipment; Elevator Parts; Exhaust Tubes
- F — Ferrules; Floor Scrubbing Machines; Food Processing; Furniture
- G — Gravity Carrier Systems; Grease Guns
- H — Handles; Hardware Items; Heat Exchangers; Hydraulic Hoists
- I — Irrigation Lines
- L — Ladders; Lamps; Laundry Machinery; Lawn Mower Parts; Lubricating Systems
- M — Meter Parts; Motorcycles; Mufflers
- N — Nozzle Tubes
- O — Office Equipment; Oil Burner Parts; Oiler Tubes
- P — Perforated Tubes; Petroleum Equipment; Playground Equipment; Pneumatic Conveyors; Pressure Tubing
- R — Railings; Road Machinery
- S — Sewing Machines; Sports Equipment; Spraying Equipment
- T — Torque Tubes; Transformers; Tricycles
- V — Vacuum Cleaner Parts
- W — Washing Machines
- X — X-Ray Equipment

QUALITY! Revere Electric Welded Steel Tubes are structurally stable, uniform in temper, and of correct analysis. Since they are formed by welding steel strip, walls are absolutely uniform. The finish is controlled and particularly suitable for plating, lacquering, painting, other coating processes. Surface is excellent for sliding parts. Available in sizes up to 4½" O.D. and in wall thicknesses to 3/16", somewhat heavier walls can be supplied in certain diameters. Our Technical Advisory Service is at your command. Write the Revere Executive Offices.

REVERE

COPPER AND BRASS INCORPORATED

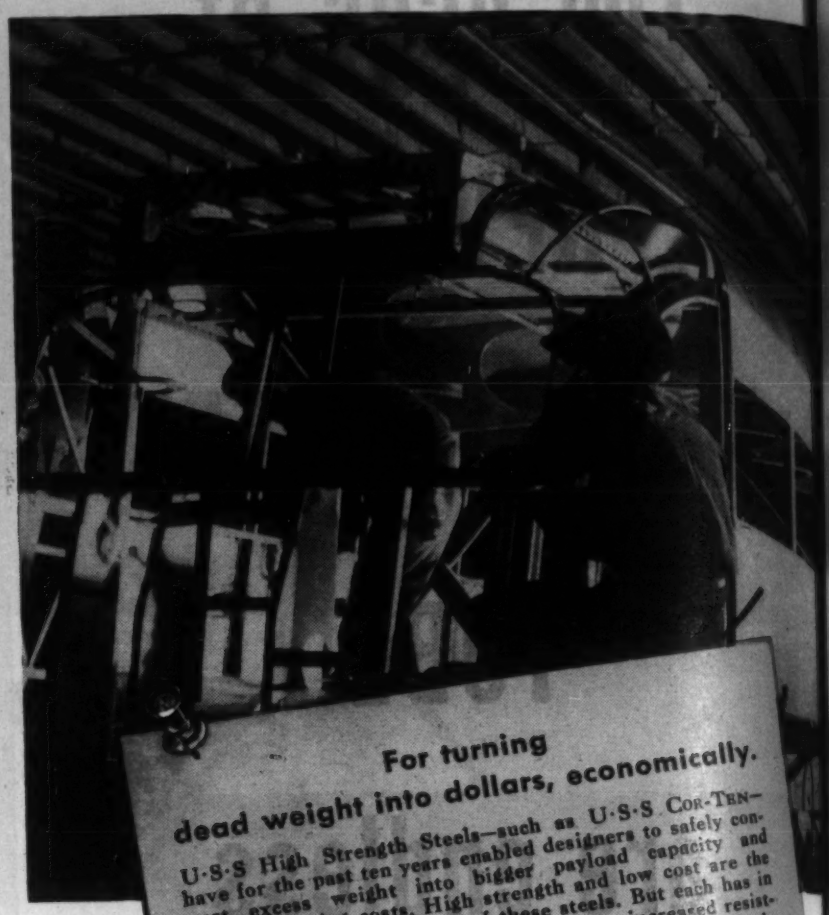
Founded by Paul Revere in 1801

Executive Offices: 230 Park Avenue, New York 17, N. Y.

What's on your drawing

Does your product need heat resistance?

Among the most important developments of the war are the advances made in perfecting and applying high temperature resisting steels. In U·S·S Stainless and Heat Resisting Steels the designer has at his command a complete line of steels especially developed to retain high strength at high temperatures. Some can safely withstand temperatures up to 2100°F. U·S·S Chromium and Chrome Nickel Steels have outstanding ability to resist wear and cavitation resulting from contact with grit, turbulent vapors, etc. Designers of turbo superchargers, steam and gas turbines, and jet propulsion devices will find in these steels the answer to many of their problems.

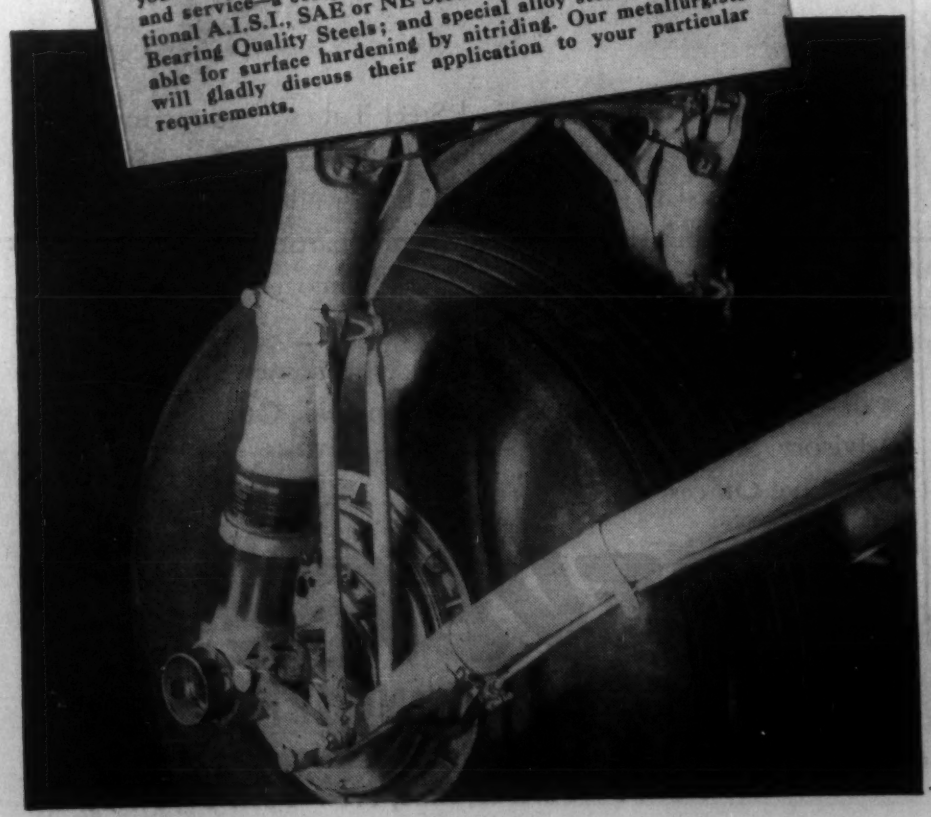


For turning
dead weight into dollars, economically.

U·S·S High Strength Steels—such as U·S·S Cor-Ten—have for the past ten years enabled designers to safely convert excess weight into bigger payload capacity and lower operating costs. High strength and low cost are the outstanding characteristics of these steels. But each has in varying degree other desirable properties—increased resistance to atmospheric corrosion, to wear, impact shock, vibration or fatigue, easy fabrication—so that the designer can obtain whatever combination of properties is necessary for top efficiency.

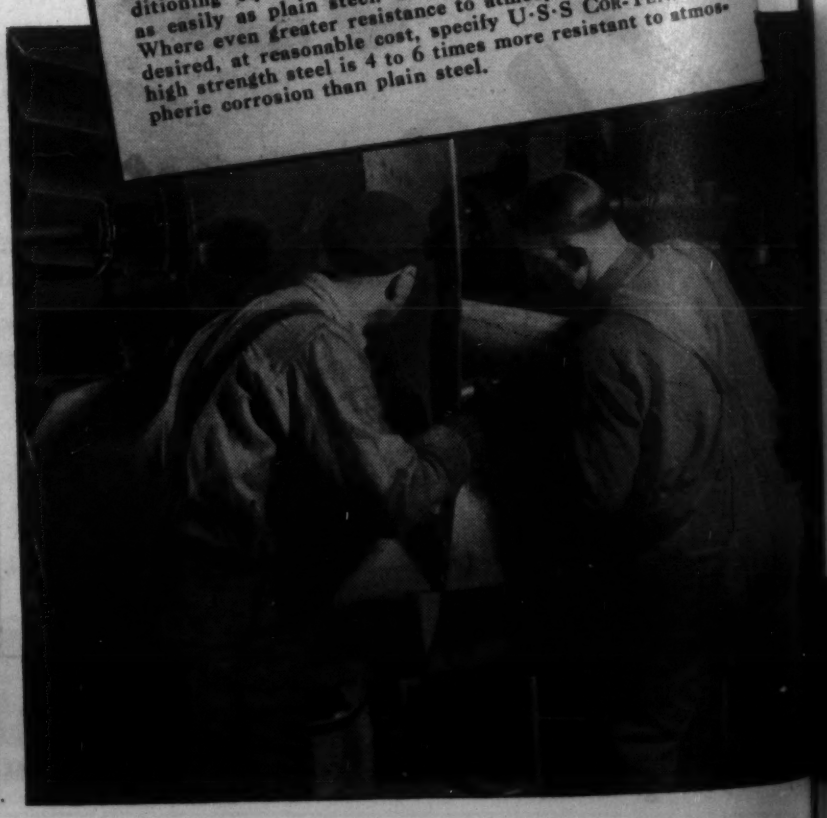
When special
made-to-measure steels are needed.

What amounts to a revolution in the manufacture of steels for severe and unusual service has taken place during these war years. In U·S·S Carilloy Alloy Steels you will find the last word in these developments. Steels that will enable you to meet practically every requirement of fabrication and service—a complete range of superior quality constructional A.I.S.I., SAE or NE Steels; Aircraft Quality Steels; Bearing Quality Steels; and special alloy steels most suitable for surface hardening by nitriding. Our metallurgists will gladly discuss their application to your particular requirements.



Here's low cost resistance to corrosion.

Although it costs only about 5% more than plain steel, U·S·S Copper Steel has *double* the resistance to atmospheric corrosion. By taking advantage of this fact you can economically design longer life into railroad cars, metal cabinets, centrifuges, refrigerating, ventilating and air conditioning equipment, tanks and ductwork. It fabricates as easily as plain steel. Can we tell you more about it? Where even greater resistance to atmospheric corrosion is desired, at reasonable cost, specify U·S·S Cor-Ten. This high strength steel is 4 to 6 times more resistant to atmospheric corrosion than plain steel.



boards for tomorrow?

BUSES or BABY CARRIAGES
STEAM TURBINES or ELECTRIC FANS
VACUUM TOWERS or VACUUM CLEANERS

remember—9 TIMES OUT OF 10 STEEL WILL DO IT BETTER

WITH most of the advantages of steel, product designers are well familiar. But it should be kept in mind that steel's potentialities for the future have, during these war years, been greatly enhanced.

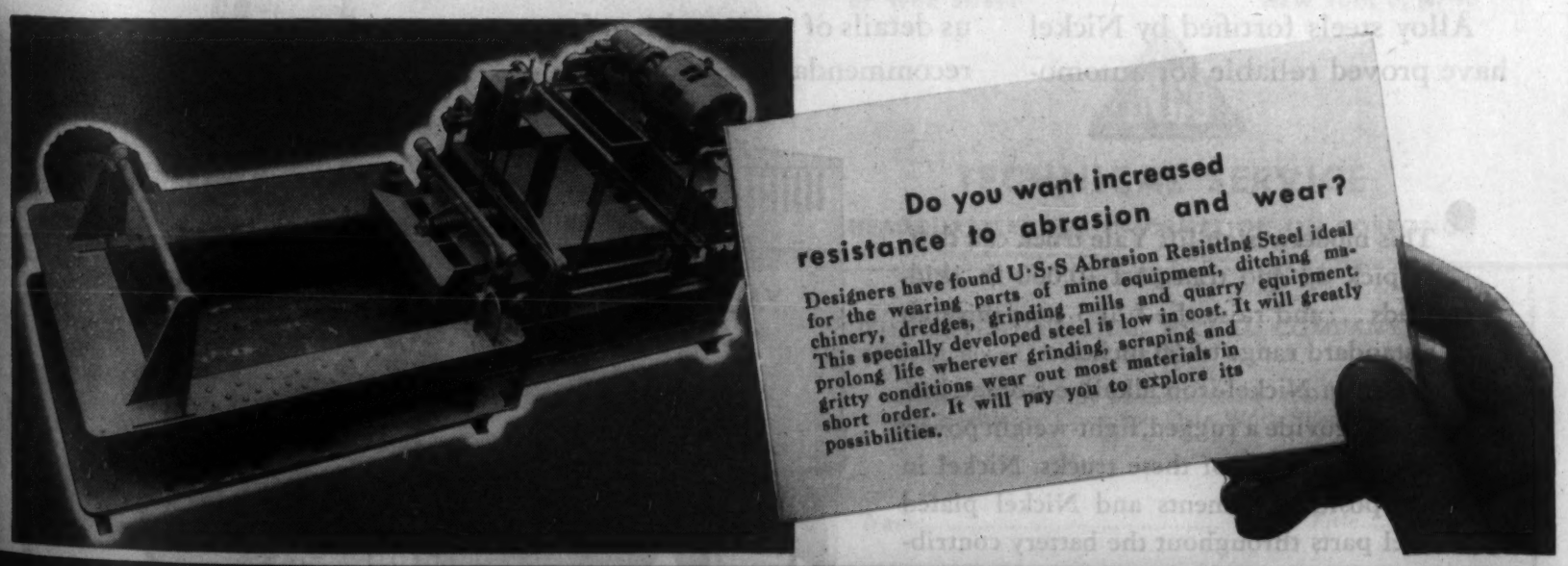
New, finer steels have been developed. Steel producing and processing techniques have been improved. Faster and more efficient methods of applying steel have been discovered.

New uses for steel—either alone or in combination with other materials—have been turned up and proved practicable.

To help you in taking full advantage of the many desirable properties that steel can contribute to your postwar product—that will make it more durable, more efficient, less costly to manufacture and easier to sell—the nation's largest organization of specialists in steel is ready to assist you.

CARNEGIE-ILLINOIS STEEL CORPORATION
Pittsburgh and Chicago

Columbia Steel Company, San Francisco, *Pacific Coast Distributors*
United States Steel Supply Company, Chicago, *Warehouse Distributors*
United States Steel Export Company, New York



UNITED STATES STEEL

NICKEL ALLOY STEELS Strengthen

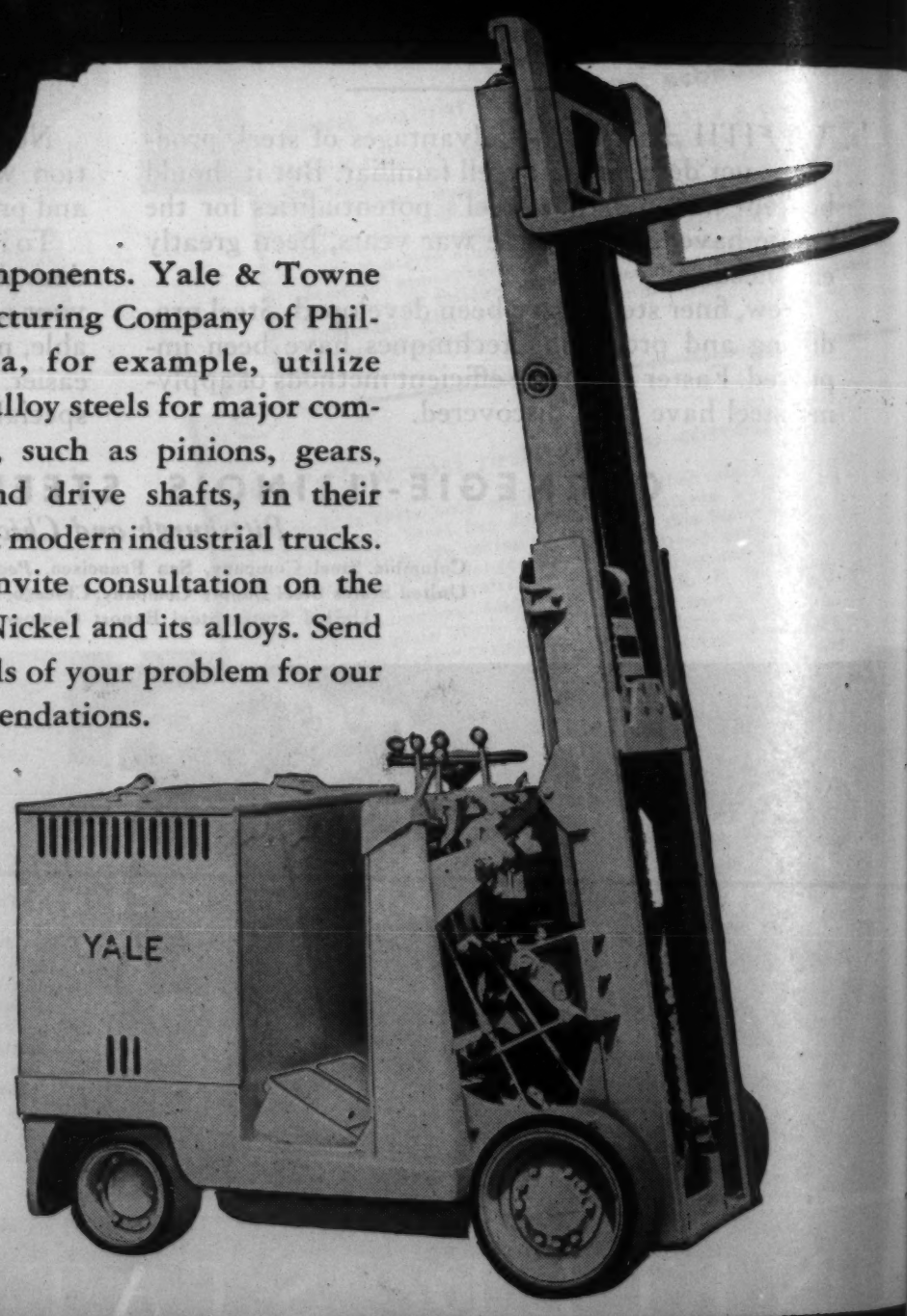
PARTS LIKE THESE

Strength of steel may be increased by additions of Nickel... without sacrificing ductility... but that's not the whole story.

Nickel additions improve toughness and promote depth hardening in heavy sections. In addition, Nickel intensifies the effect of other alloy elements.

Alloy steels fortified by Nickel have proved reliable for automotive components. Yale & Towne Manufacturing Company of Philadelphia, for example, utilize Nickel alloy steels for major components, such as pinions, gears, axles and drive shafts, in their compact modern industrial trucks.

We invite consultation on the use of Nickel and its alloys. Send us details of your problem for our recommendations.



● This modern high-lift Yale truck can deftly pick up and transport 10,000 lb. skidloads... and raise the full 5 tons through a standard range of 60 inches.

Edison Nickel-iron alkaline storage batteries provide a rugged, light-weight power source in many of these trucks. Nickel in the positive elements and Nickel plated steel parts throughout the battery contribute to its long dependable service.

THE INTERNATIONAL NICKEL COMPANY, INC. 67 WALL STREET NEW YORK 5, N.Y.

"HIGHLY AERATED NaCl SOLUTION SHORTENS PUMP LIFE"

"One of our pumps handles an absorption tower solution saturated with sodium chloride and containing 10% sodium hydroxide," wrote a chemical plant engineer. "The highly aerated solution is held at room temperature. We're not at all satisfied with the service life of this pump. Can you offer any help?"

Similar problems have often been brought to INCO Technical Service.

Among the reports in the Corrosion Data File were several dealing with aerated sodium chloride solutions under virtually the same conditions described by this engineer.

Sent to him immediately, therefore, was information for which he had asked, substantiated by performance records in actual installations.

An all-Monel pump, he was told, had been found to give most satisfactory service. As an alternative, he might use a Monel impeller with Ni-Resist casing. Either would solve his problem, effect worthwhile savings in repair and maintenance costs.

"OUR CONDENSER TUBES CORRODE MUCH TOO RAPIDLY"

"Our big headache," said a manufacturer of arsenic trichloride, "is the trouble we have with corrosion of condenser tubes. We've tried other materials, but so far the results have been disappointing."

In addition to arsenic trichloride, the corrosives included small amounts of sulfur monochloride, dry hydrogen chloride and sulfur dioxide, antimony chloride, sulfur and chlorine.

INCO Technical Service submitted for testing purposes samples of Monel, Nickel and Inconel, along with specimens of two other metals.

After 3 months' exposure, corrosion rates were computed:

	ipy*
Monel†	less than 0.001
Nickel†	less than 0.001
Inconel†	less than 0.001

Subsequent retubing of the condensers with pure nickel produced excellent results.

* *ipy — inches penetration per year of continuous exposure*
† *average of 2 specimens*

They needed protection against

Corrosive Chemicals

. . . and here's what they did about it

Like these men, you too may have equipment that needs protection against corrosion.

INCO Technical Service invites you to make use of its facilities *just as they did.*

Our Corrosion Data File is extensive and up-to-date. It contains readily accessible data from thousands of plant tests, laboratory studies and technical papers. Any of these data, except those developed under confidential arrangements, are at your disposal.

The very information for which you are looking may be known to us at this moment. If it is not, perhaps corrosion tests in your own plant may provide an answer. Such tests will be undertaken without cost or obligation... without interfering with production.

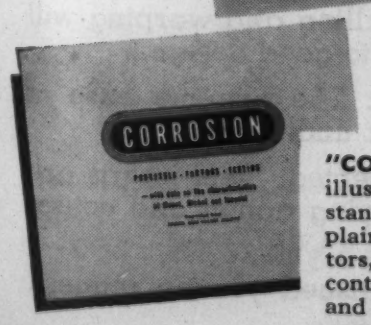
As the initial step toward the solution of your problem, mail the coupon below. We'll send you at once a copy of the Corrosion Data Work Sheet on which you can jot down significant details for review by our technical staff.

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street New York 5, N. Y.

INCO

TECHNICAL SERVICE

HEADQUARTERS FOR INFORMATION ON CORROSION



"CORROSION" is the title of a new 52-page illustrated booklet written to help you understand and analyze corrosion problems. It explains corrosion processes and controlling factors, discusses testing methods and procedures, contains a number of helpful graphs, drawings and tables. This booklet provides you with a comprehensive groundwork for the study of corrosion resistant characteristics of several commercial materials, including Monel, Nickel and Inconel. Copies will be mailed with the Corrosion Data Work Sheet or upon separate request.

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street, New York 5, N. Y.

Please send a copy of the booklet *"CORROSION"* along with our Corrosion Data Work Sheet.

Name..... *Title*.....

Company.....

M. & A. 6-45

Address.....

City..... *State*.....

design with magnesium

FABRICATED IN ALL USUAL FORMS

1—SAND CASTINGS

2—PERMANENT MOLD CASTINGS

3—DIE CASTINGS

4—ROLLED SHEET, PLATE, AND STRIP

5—EXTRUSIONS: ROD, BAR, TUBING, AND SPECIAL SHAPES

6—FORGING: PRESS AND HAMMER METHODS

7—FORMED BY BENDING, DRAWING, PRESSING, AND SPINNING

JOINED BY ALL COMMON METHODS

RIVETING

GAS WELDING

ARC WELDING

SPOT WELDING

FLASH WELDING

DESIGN NOTES ON DIE CASTING (No. 3)

The general considerations of good sand casting design also apply to good die casting design, with the exception that thin sections are desirable and heavy sections should be avoided. Heavy sections can be avoided by the use of I-beam or rib construction, or it may be possible to core out a heavy section.

Sharp corners and abrupt section changes result in stress concentration. These can be avoided by the use of generous fillets and by gradually blending thin sections into heavy sections.

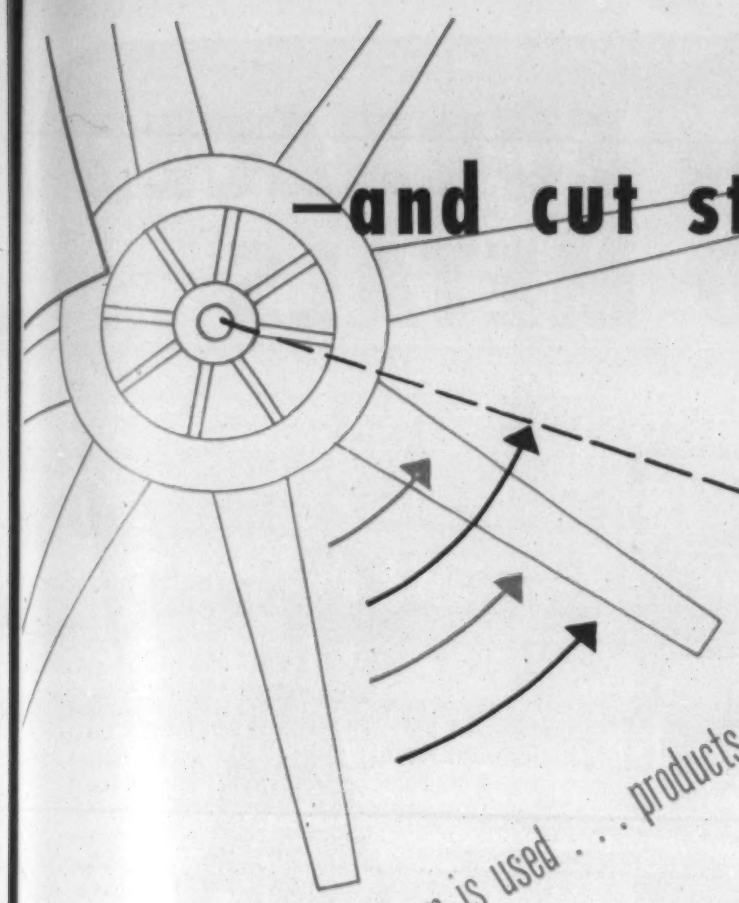
Draft on internal walls should not be less than 0.010 inch per inch on a side with as much more as will not interfere with the function of the part. Galling and warping will be reduced by so doing. Draft on external walls also contributes to good design.

Undercuts decrease casting rates and interfere with clean-up. The extreme ease of machining of magnesium, however, often eliminates the need for undercuts.

Inserts should be used where severe wear or bearing load is expected. Steel inserts are preferred over other metals because there is less chance of alloying action and consequent contamination during scrap refining.

Full details on fabricating magnesium in all forms will be furnished you on request.

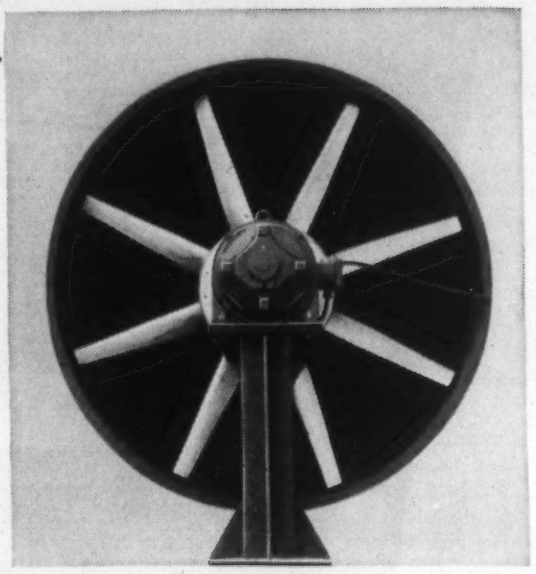
DOW'S LONG EXPERIENCE WITH MAGNESIUM IS AVAILABLE TO YOU—*CONSULT WITH DOW*



—and cut starting inertia

when magnesium is used . . . products that move start with an advantage

power consumption is reduced . . . moving parts have longer life



Cutting dead weight is one of magnesium's outstanding jobs—and that means more than simply reducing the over-all non-productive load in things that move.

It means, for instance, reduction of starting inertia in all sorts of equipment with parts that frequently start and stop . . . high-speed rotating members . . . and parts with reciprocating movements at high speeds. It means major reduction in wear and tear, in maintenance and replacement of moving parts. Moreover, it means material decrease in power consumption.

Dowmetal Magnesium Alloys are particularly well adapted to many such applications. In addition to weight economy, they give you strength, toughness, machinability, corrosion resistance, and adaptability to fabrication in all common forms.

When you design moving parts, look to magnesium—and cut starting inertia!

LEADING FABRICATOR FOR 29 YEARS

As the pioneer in structural magnesium, Dow is the logical and best source for technical data on all phases of its fabrication and application. The extensive Dow engineering service . . . developed to assist you in your own product planning . . . is backed by 29 years' experience. Simply contact the nearest Dow office.

DOWMETAL

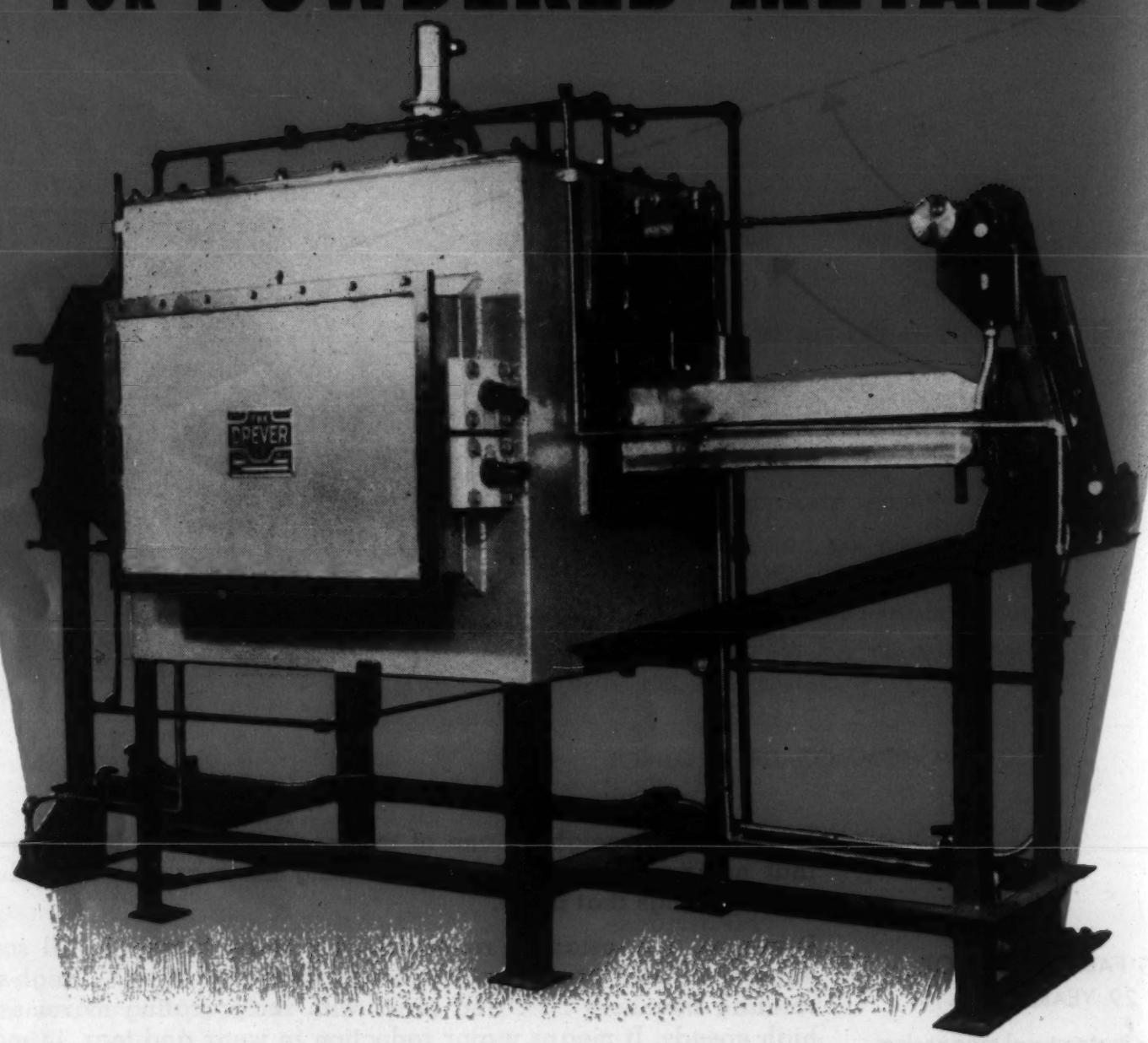
magnesium

THE METAL OF MOTION

MAGNESIUM DIVISION, THE DOW CHEMICAL COMPANY, MIDLAND, MICHIGAN

New York • Boston • Philadelphia • Washington • Cleveland • Detroit • Chicago • St. Louis • Houston • San Francisco • Los Angeles • Seattle

DREVER LEADS IN FURNACES FOR POWDERED METALS



Industry is on the threshold of broad and significant use of powdered metals. Developed to a high degree of perfection for war-time requirements, these materials will play an increasingly important role in post-war production.

The experience of the Drever Company in designing and building furnaces for the reduction of oxides and the sintering of powdered metal parts extends over a period of years. Our close association with the problems involved is reflected in the continued successful operation of Drever equipment.

The Drever Ammonia Dissociator provides the ideal inert atmosphere; furnace temperatures are controlled within extremely narrow limits up to 2300° F.; required atmosphere pressures up to 4″ of water are maintained within the furnace; and efficient material handling mechanisms are an integral part of the furnace design.

Drever engineers will be pleased to discuss your plans with you.

THE DREVER CO.

750 E. VENANGO ST., PHILA. 34, PENNA.

PRESSURE QUENCHES CONTINUOUS FURNACE LINES • HEAT TREATING FURNACES

NEW YORK & NEW ENGLAND—GERALD B. DUFF, 68 CLINTON AVE., NEWARK 5, N. J.

Advertisement JUNE, 1945

COPPER ALLOY BULLETIN

REPORTING NEWS AND TECHNICAL DEVELOPMENTS OF COPPER AND COPPER-BASE ALLOYS

Prepared Each Month by the Bridgeport Brass Co. "Bridgeport" BRASS CO. *Headquarters for BRASS, BRONZE and COPPER*

Cold Heading for Greater Efficiency, Wide Range of Engineering Alloys Available

To conserve material and reduce manufacturing costs, many items such as screws, solid and hollow rivets, bolts, nuts and fastenings of all sorts have long been made from wire or rod by cold upsetting and cold extrusion processes. Threading, where necessary, was generally performed by cold rolling. Since very little, if any, machining is required, wire for this purpose must be extremely malleable and ductile in addition, of course, to possessing satisfactory strength and stiffness. Most important also are layout of operations, design of tools and skillful metal craftsmanship.

With the development of more powerful cold heading machines that permit the manufacture of larger and more difficult items than is possible with lighter equipment, many other articles besides fastenings can be made, by cold forging which were formerly made by other methods of manufacture. Frequently cold forgings are replacing castings with great improvement in strength and wear resistance.

Fortunately, non-ferrous metallurgical research has anticipated mechanical advancements in machinery. In addition to a wide range of brasses with varying amounts of copper, with and without lead and tin, high strength engineering alloys of the silicon bronze type such as Duronze I, and Duronze V are now available. Cold headed parts, therefore, can be made to the highest engineering requirements—great strength, wear and fatigue resistance, freedom from failures due to stress corrosion cracking. Pole line and marine hardware, valve stems, hexagon nuts, screws, wire and cable connectors, etc., etc., and other important parts for engineering items are therefore being made by cold forging.

Bridgeport has made a specialty of supplying wire of the correct temper, surface finish and composition necessary to meet the severe requirements of modern mass production methods. Heading wire must be of special high quality—free from scratches, folds, blisters and similar imperfections which are not important when the wire is used for other types of operations. Otherwise cracks and breaks will appear on the surface especially where the original material has been upset to larger diameter. Also the wire must be extremely malleable so that it will fill out the die without developing dangerous shearing stresses involved in making bolts or rivets with large heads. At the same time, it must be of the correct temper so that the finished bolt, for example, will be stiff and strong on the shank.

Listed in table form are eleven alloys which will meet most requirements and specifications. The services of our Laboratory are freely offered to help in the selection of the most suitable alloy.

High Brass—16— (approximately 65% copper, 35% zinc). Very ductile and malleable. Special temper and surface. Most popular of the heading wire alloys. Used for making all types of machine, wood and cap screws, solid and hollow rivets, special fastenings.

70-30 Brass—37—(approximately 70% copper, 30% zinc). Slightly more ductile

(*Continued on page 2, column 2*)

ROD AND WIRE ALLOYS FOR COLD HEADING

	High Brass 16	70-30 Brass 37	Low Brass 5	Red Brass 85	Comi. Bronze 25	Light Leaded Brass 43	Low Leaded Brass 41	Naval Brass 45	Duronze I 813	Duronze V 609	Phono Electric 840
ANALYSIS											
Copper %	65.0	70.0	80.0	85.0	90.0	65.0	63.0	60.0	97.6	98.0	98.6
Lead %						.3	.75				
Tin %								.75	1.4		1.4
Zinc %	35.0	30.0	20.0	15.0	10.0	34.7	36.25	39.25			
Silicon %									1.0	2.0	
MECHANICAL PROPERTIES											
Ten. Strength psi Hard*	65,000	65,000	62,000	59,000	50,000	65,000	65,000		80,000	80,000	65,000
Ten. Strength psi Soft	50,000	50,000	46,000	41,000	40,000	50,000	50,000	57,000	45,000	45,000	40,000
Elongation, % in 2" Hard*	25	25	12	12	13	25	15		12	12	10
Elongation, % in 2" Soft	60	60	50	48	50	60	50	47	50	50	40
PHYSICAL CONSTANTS											
Melting Pt. (Liq) °F	1710	1750	1830	1880	1910	1710	1700	1650	1940	1940	1970
Density, lbs./cu. in.	.306	.308	.313	.316	.318	.306	.306	.304	.317	.316	.321
Coeff, Ther. Exp./°F 77°F to 572°F x 10–6	11.3	11.1	10.6	10.4	10.2	11.3	11.3	11.8	9.3	9.8	9.9
Thermal Conduct. Btu/sq. ft/ft/hr/°F@68°F	67	70	81	92	109	67	67	67	35	27	120
Elec. Cond. %IACS @68°F Soft	27	28	32	37	44	27	26	26	13	9	48
Mod. of Elas. (Tension), psi	15,000,000	16,000,000	16,000,000	17,000,000	17,000,000	15,000,000	15,000,000	15,000,000	17,000,000	17,000,000	17,000,000
FABRICATION PROPERTIES											
Machinability Rating**	30	30	30	30	20	50	60	30	30	30	20
Cold Working	E	E	E	E	E	E	G	F	E	E	E
Hot Working	P	F	F	G	G	P	P	E	E	E	G
Hot Working Range, °F		1350–1550	1500–1650	1450–1650	1400–1600			1200–1500	1300–1600	1300–1600	1450–1600
SPECIFICATIONS											
A. S. T. M.	B134 Alloy #7	B134 Alloy #6	B134 Alloy #4	B134 Alloy #3	B134 Alloy #2			B21 Gr. A	B98 type B B99 type B	B98 type B B99 type B	B105 Gr. 40
Federal	QQ-W-321 Gr. A&B	QQ-W-321 Gr. C						QQ-B-636a Gr. A	QQ-C-591a Class B	QQ-C-591a Class B	
Navy								46B6k			
Army			57-217A		57-171						

*Hard temper values are for wire of commercial hard drawn temper suitable for cold heading.
**Machinability Rating—Free Cutting brass—100.
E—Excellent G—Good F—Fair P—Poor

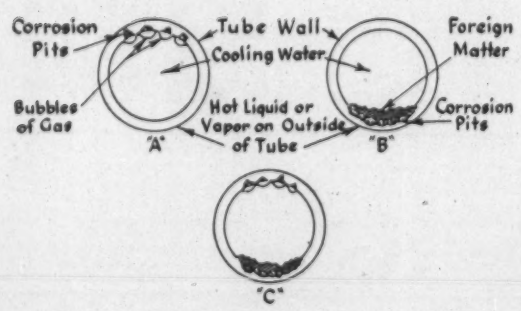
COPPER ALLOY BULLETIN

CAUSES OF CORROSION

This article is one of a series of discussions by C. L. Bulow, research chemist of the Bridgeport Brass Company.

PREVENTING THE ACCELERATION OF CORROSION BY REDUCING THE HOT WALL EFFECT

Since we last discussed (December 1944 issue of the Copper Alloy Bulletin) the acceleration of corrosion by the hot-wall effect, numerous questions have come up about the practical applications of the suggestions offered to increase service life by offsetting this effect. Briefly the mechanism of the hot-wall effect consists of the formation of hot spots under bubbles of gas which are repeatedly formed at the same points. The bubbles of gas acting as heat insulating barriers hinder the liquid from cooling the metal surface and the resulting local high temperature accelerates the rate of corrosion. In addition, deposits of foreign matter (rust, certain types of silt, etc.) may also permit a local high temperature to develop under the deposit.



In figures "A" and "B" the effects of bubbles of gas and porous deposits are shown in horizontally held heat exchanger tubes where the heat is moving from the outside surface towards the inside surface of the tube.

Frequently both bubbles of gas and deposits of foreign material will separate from the corrosive liquid leading to the condition illustrated in figure "C". Since the rate of corrosion is increased by high local temperature every effort should be made to maintain as low a temperature as possible and keep continued, uninterrupted heating down to a minimum.

Cold Heading

(Continued from page 1)

than brass heading wire. Used for making exceptionally large heads and certain types of hollow rivets.

Low Brass—5—(approximately 80% copper, 20% zinc). Light golden color—very malleable, more resistant to stress corrosion cracking and general corrosion than yellow brass. Used for jewelry findings, parts with large upset heads.

Red Brass—85—(approximately 85% copper, 15% zinc). Rich golden color. For ornamental jewelry, special rivets and fastenings for vanity cases, lipstick holders. Very malleable. Has good corrosion resistance.

Commercial Bronze —25— (approximately 90% copper, 10% zinc).—Bronze color, resists season cracking. Recommended for outdoor construction.

Naval Brass—45—(approximately 60% copper, 0.75% tin, balance zinc). Used for cold heading bolts for U. S. Navy requirements.

Low Leaded Brass —41— (approximately 63% copper, 0.75% lead, balance zinc). Used where cold heading and such machinability as drilling, reaming, threading, slotting, tapping is required.

Light Leaded Brass—43—(approximately 65% copper, 0.3% lead, balance zinc). For operations requiring good cold heading with light machining.

Duronze V—609—(approximately 98% copper, 2% silicon). Does not fail from stress corrosion cracking. Exceptionally malleable even in its hard drawn condition. Excellent for making all types of screw products by cold upsetting and roll threading. Recommended for making bolts with exceptionally large heads. Tensile strengths of finished bolts average above 100,000 lbs. per square inch. When properly made, it is not necessary to provide heat treatment of the finished cold upset items to relieve stresses. Fine for outdoor construction where brass and steel are not satisfactory. For cap and machine screws, bolts, cold upset nuts, wire and cable connectors, pole line and marine hardware, water meter bolts, valve parts, etc.

Duronze I—813—(approximately 97.6% copper, 1.4% tin and 1% silicon). Resists season cracking and corrosion from sea water. Similar in physical properties and applications to Duronze V.

Phono-Electric—840—(approximately 98.6% copper, 1.4% tin). Has an electrical conductivity approximately 40% that of pure copper. Very malleable—stronger than copper. Used for pole line hardware and electrical parts where strength, toughness, corrosion resistance from weathering and good electrical conductivity are needed.

NEW DEVELOPMENTS

This column lists items manufactured or developed by many different sources. None of these items has been tested or is endorsed by the Bridgeport Brass Company. We will gladly refer readers to the manufacturer or other sources for further information.

Automatic Controls are reported for built-in application on machine tools to provide feed and sequencing in any combination that includes not more than forty functions in a complete cycle. Initial setup for automatic operation is made at the time an operator puts the equipped machine through the movements required by a given work piece. The machine will then duplicate these movements including rapid traverse, feed, indexing, speed changing in any combination to the maximum total of forty. **No. 612**

An Emulsion Lubrication Apparatus is reported to form a new type emulsion which will greatly increase the life of machine tools and the speed at which they can be operated. The anti-corrosive and anti-friction effects can be obtained by emulsions as dilute as 98 parts of water to 2 of oil. It is claimed a unit can be designed to any tank capacity whatever. **No. 613**

A Retracting Tool Holder that mounts on a lathe carriage in place of the usual tool post and carries a bit or a boring bar is reported. The bit or the bar is held in a pivoted head on the side of the holder so the head rocks the tool away from the work when a supporting latch rod is withdrawn from beneath it. **No. 614**

An Electronic Detector is said to warn of mercury vapor in the atmosphere to protect workers in the manufacture of chemicals, electrical apparatus, glass, and in metal mining and smelting for dangerous concentrations. It is claimed to read 1 part per billion. **No. 615**

A New Band Saw Blade designed to cut soft brass, aluminum; and other soft metallic and non-metallic materials is reported. Considerable space between teeth is said to provide the room for chip clearance required by these materials. The blade can be supplied to fit any standard band saw-machine. **No. 616**

A Work Positioner for welding, grinding, and parts assembly has been made available. It mounts a 16-in. table that can be rotated through a complete circle. Tilted through a range of 150 deg. and locked at a desired angle. It has a weight capacity of 100 lbs. **No. 617**

A New Flexible Tube Assembly acts, it is claimed, as an expansion joint in a rigid pipe line. It consists of a flexible metal tube welded in place between standard brass pipe nipples. The units are available for ¼ to 2-in. pipe lines. **No. 618**

PRODUCTS OF THE BRIDGEPORT BRASS COMPANY

Executive Offices: BRIDGEPORT 2, CONN.—Branch Offices and Warehouses in Principal Cities

SHEETS, ROLLS, STRIPS—*Brass, bronze, copper, Duronze,* for stamping, deep drawing, forming and spinning.

CONDENSER, HEAT EXCHANGER, SUGAR TUBES—For steam surface condensers, heat exchangers, oil refineries, and process industries.

PHONO-ELECTRIC* ALLOYS—High-strength bronze trolley, messenger wire and cable.

WELDING ROD—For repairing cast iron and steel, fabricating silicon bronze tanks.

LEDRITE* ROD—For making automatic screw machine products.

"Bridgeport" BRASS

Established 1865

BRASS, BRONZE, DURONZE WIRE—For cap and machine screws, wood screws, rivets, bolts, nuts.

DURONZE ALLOYS—High-strength silicon bronzes for corrosion-resistant connectors, marine hardware: *hot rolled sheets* for tanks, boilers, heaters, flues, ducts, flashings.

COPPER WATER TUBE.

FABRICATING SERVICE DEPT.—Engineering staff.

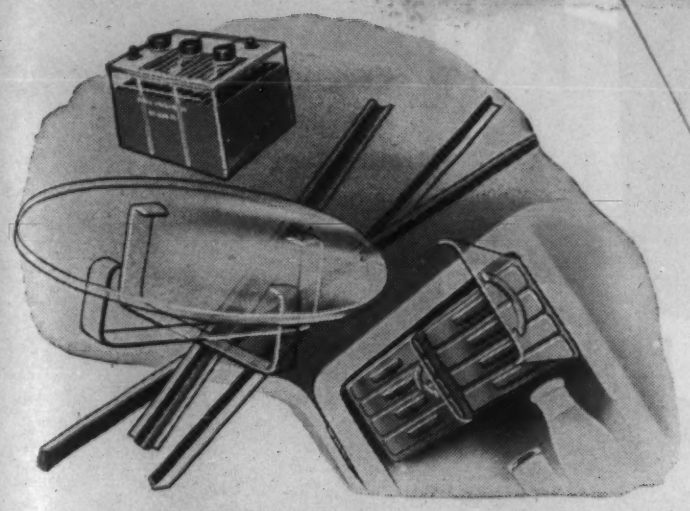
BRASS AND COPPER PIPE

Note: Bridgeport products are supplied in accordance with existing priority regulations.

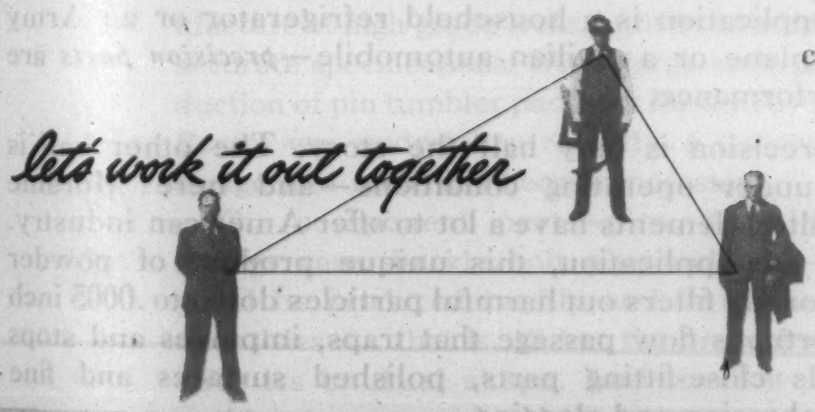
*Trade name.

BRIDGEPORT **BRASS**

Why a comb is big plastics news



Most of us take a comb more or less for granted. But to the plastics industry, *this* comb is different. Made of the No. 1 postwar plastic—Styron (Dow Polystyrene)—it is the "measuring stick" for plastics in respect to appearance, quality, price and moldability. There are a number of reasons for this leadership. First, Styron comes from the only privately owned synthetic styrene plant with sufficient facilities to care for molders' postwar requirements. This means availability—and it means an attractive price; add to these advantages Styron's long recognized superior physical properties, and the list of potential uses becomes almost unlimited. Why not find out how Styron fits into *your* postwar plans?



We at Dow know from experience that success in plastics is not a one-man nor even a one-industry job. It calls for the combined skill and cooperation of manufacturer or designer plus fabricator plus raw materials producer. Working together, this team saves time and money and puts plastics to work successfully. Call us—we'll do our part.

THE DOW CHEMICAL COMPANY
MIDLAND, MICHIGAN

New York, Boston, Philadelphia, Washington, Cleveland, Detroit
Chicago, St. Louis, Houston, San Francisco, Los Angeles, Seattle

PRESENT AND POTENTIAL USES—Lighting fixtures and displays; insulators; hydrometers; battery cases; funnels; bottles; closures; food handling equipment; pharmaceutical, cosmetic, and jewelry containers; jewelry; advertising items; refrigerator parts; pens; pencils; chemical apparatus; lenses; decorative objects and trim.

PROPERTIES AND ADVANTAGES—Beautiful, clear, translucent; "pipes" light through rod around corners, etc.; resistant to acids and many alkalies; stable at low temperatures; excellent electrical properties; broad color range; low specific gravity providing more moldings per pound; low water absorption.

STYRON

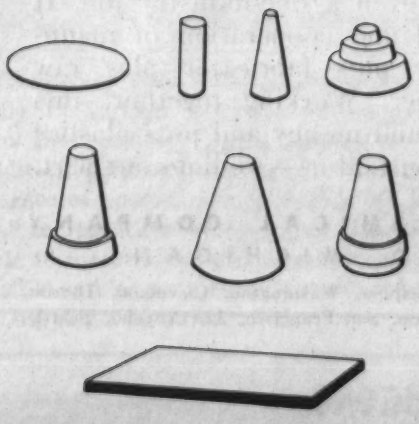
(DOW POLYSTYRENE

DOW

PLASTICS

STYRON • ETHOCEL • ETHOCEL SHEETING • STYRALOY
SARAN • SARAN FILM • STRIPCOAT

*MORAINE POROUS METAL



MPM elements for filtration, separation, diffusion, flow control, flame arresters.

Whether the application is a household refrigerator or an Army tank, a fighter plane or a civilian automobile—*precision parts* are the heart of performance.

But *attaining* precision is only half the story. The other half is *maintaining* it under operating conditions—and here Moraine Porous Metal filter elements have a lot to offer American industry. Designed into the application, this unique product of powder metallurgy uniformly filters out harmful particles down to .0005 inch—provides a tortuous flow passage that traps, impinges and stops dirt—safeguards close-fitting parts, polished surfaces and fine orifices against abrasion and clogging.

If your products or processes involve a flowing medium that has contact with precision parts, you should investigate Moraine Porous Metal. Our engineers will work with you to determine the most efficient grade, size, shape.

WAR BONDS SAVE LIVES

MORAINE PRODUCTS DIVISION OF **GENERAL MOTORS**

DAYTON, OHIO

Here again—
the answer was an *Extruded Shape*

The E. T. Fraim Lock Company of Lancaster, Pa., has a world-wide reputation for the manufacture of high grade locks, built to unusually accurate specifications. When large-scale production of pin tumbler padlocks for the Armed Forces was undertaken recently, a review of design and materials became necessary.

The component parts—pins, tumblers, springs, case, shackle, bolt, plug and keys—all could be produced readily and in adequate quantities . . . that is, all but the brass sleeve with its unusual shape. And there *was* a problem!

Brass castings were being used, requiring machining all over for the intricate assembly. Lack of uniformity, coarse grain structure and surface roughness and irregularities left much to be desired.

The solution was found in the Anaconda Extruded and Drawn Brass Shape illustrated above. Here was wrought metal, smooth of surface and uniformly accurate in cross section. Sleeves could be "sliced" off long mill lengths—and the parts would fit drill jigs and milling fixtures without filing or fussing. Several operations, previously necessary, were entirely eliminated. Rejections were held to a minimum. And as in so many similar instances, the uniform grain structure and high rate of machinability of the extruded part made possible faster, more accurate production, saving time and tools.

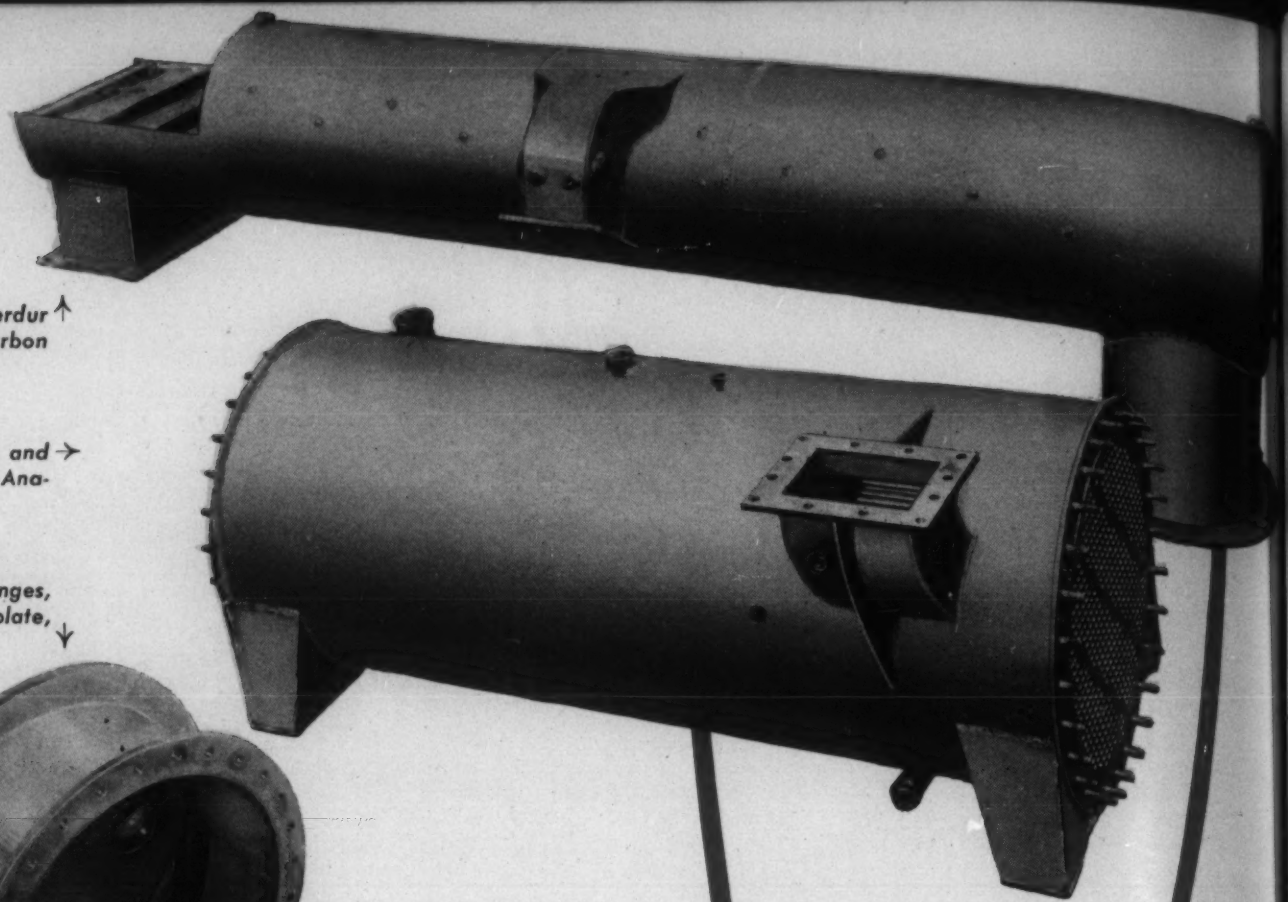
Similar design or production problems may appear in your plant, anywhere from the drawing board to the assembly bench. If they do, remember that our Technical Department will be glad to work with you. 45157

THE AMERICAN BRASS COMPANY

General Offices: Waterbury 88, Connecticut
Subsidiary of Anaconda Copper Mining Company
In Canada: ANACONDA AMERICAN BRASS LTD., *New Toronto, Ont.*

ANACONDA
from mine to consumer

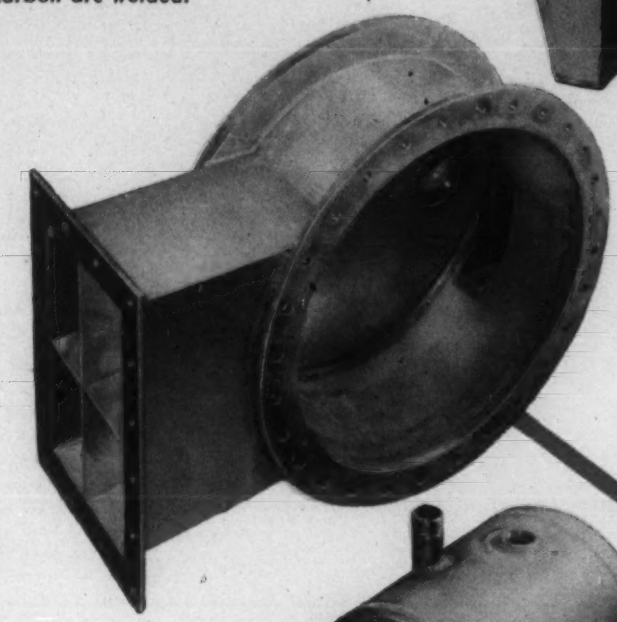
Anaconda Extruded & Drawn Shapes

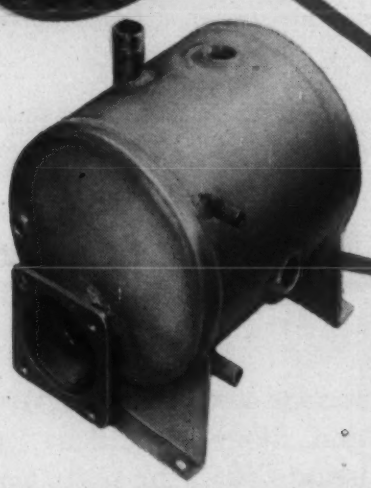


Evaporator and flume of Everdur sheet-metal construction, carbon arc welded with Everdur rod.

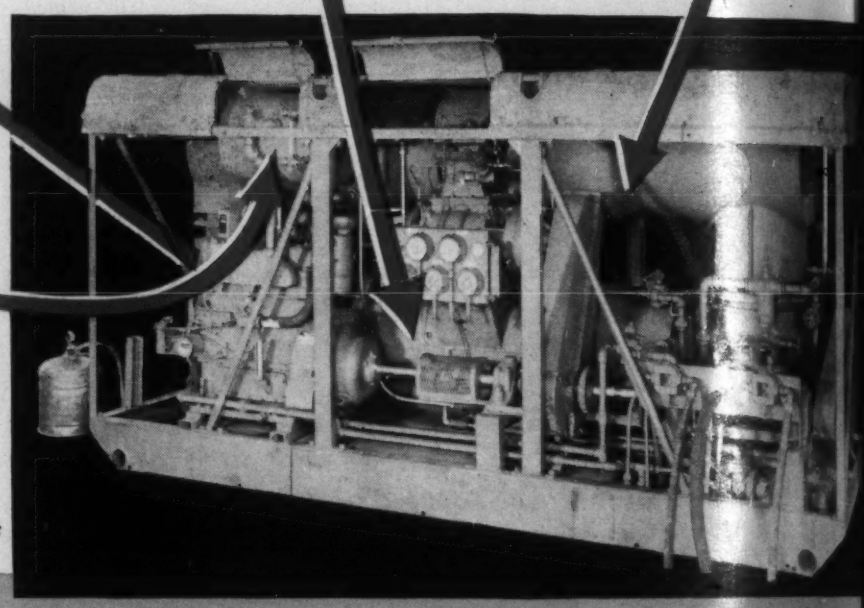
Condenser: Shell, tube sheets and bolts are Everdur; Tubes are Anaconda Arsenical Admiralty.

Discharge Head, including flanges, made of Everdur sheet and plate, carbon arc welded.





Distillate Boiler: All Everdur, including supports and pipe connections. Carbon arc welded.



Compression Type Distillation Unit Manufactured by Cleaver-Brooks Co., Milwaukee, Wisc.

SO THERE'S WATER TO DRINK FOR OUR FIGHTING MEN...

This "seagoing waterworks" uses *Everdur* for ruggedness and dependability

In amphibious operations, this Cleaver-Brooks Compression Type Distillation Unit is among the first items of equipment to be put ashore. From sea water or jungle swamp it will deliver up to 175 gallons of distilled water an hour—pure water for drinking, cooking and other purposes. Little wonder that Everdur Metal is used so extensively and effectively for these important components. For Everdur* has established an outstanding record for service in waterworks and similar fields. It combines strength and corrosion resistance in economical lightweight, welded, sheet-metal construction.

*Reg.U.S.Pat.Off.

THE AMERICAN BRASS COMPANY

General Offices: Waterbury 88, Connecticut

ANACONDA
from mine to consumer

Everdur Copper-Silicon Alloy

Naturally - **RUSSELL, BURDSALL & WARD**

were among the first to

use the DuMONT *Cyclograph*

. . . to aid in

QUALITY CONTROL

Russell, Burdsall & Ward Bolt and Nut Co. have spent years of effort to establish and maintain an enviable reputation for high and uniform quality in their products.

Realizing the unique possibilities of the Cyclograph in quality control, they were among the first to install the Cyclograph in the bolt industry. Their Cyclograph has been used to inspect many thousands of critical high-quality bolts for uniformity of properties. It has helped immeasurably in meeting the most rigid specifications.

In the highly competitive postwar market, QUALITY CONTROL will be the deciding factor in holding many customers.

IT WILL BE WORTH YOUR WHILE TO FIND OUT WHAT THE CYCLOGRAPH CAN DO FOR YOU.

© ALLEN B. DUMONT LABORATORIES, INC.

DUMONT *Precision Electronics & Television*

ALLEN B. DUMONT LABORATORIES, INC., PASSAIC, NEW JERSEY • CABLE ADDRESS: WESPEX[illegible], NEW YORK

IN CANADA: CYCLOGRAPH SERVICES, LTD. 12 JORDAN STREET, TORONTO, ONTARIO

There's a vast difference in forgings, too!

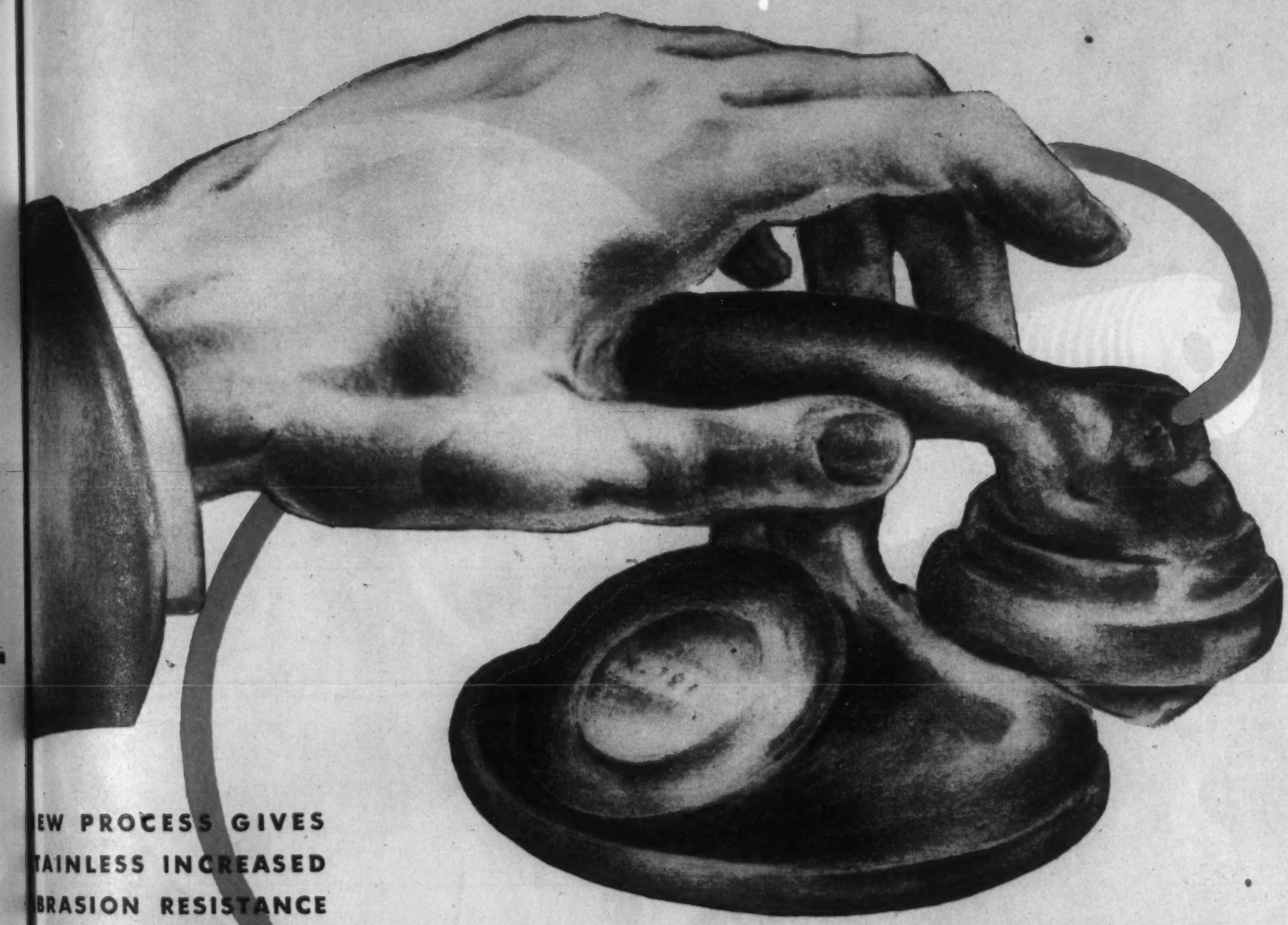
ONE of Tube Turns' tough wartime forging assignments involved a cylinder head and barrel unit for P.T. boat engines. The old forging weighed over 130 pounds. Tube Turns engineers produced this one in approximately normal forging tolerances above rough machined dimensions, weighing slightly over 80 pounds. Fifty pounds of critical metal were saved, and much expensive—and precious—machining time.

New forging production methods at Tube Turns make such savings available to all industry. If you are now at work on designs for the improvement of your present product, or for a wholly new product, you are invited to consult Tube Turns. Our engineering talent, our huge upset and mechanical press forging equipment and precision heat treating facilities have achieved remarkable results with steel and light metals. They are at your service. Write, without obligation, to Tube Turns (Inc.), Louisville 1, Ky.

TUBE TURNS *Forgings for Industry*

WITHIN YOUR REACH!

LARGEST, MOST DIVERSIFIED WAREHOUSE STOCK OF STAINLESS STEELS IN AMERICA!



NEW PROCESS GIVES STAINLESS INCREASED ABRASION RESISTANCE

This efficient new process combines the corrosion resistance of Stainless with the abrasion resistance of a nitrided surface. Both austenitic and martensitic grades of Stainless now can be hardened.

Stainless Surface Hardening Company, 250 Bent Street, Cambridge 41, Mass. is a subsidiary of Industrial Steels, Inc.

JMLco C1-F1

LET ONE CALL DO IT ALL

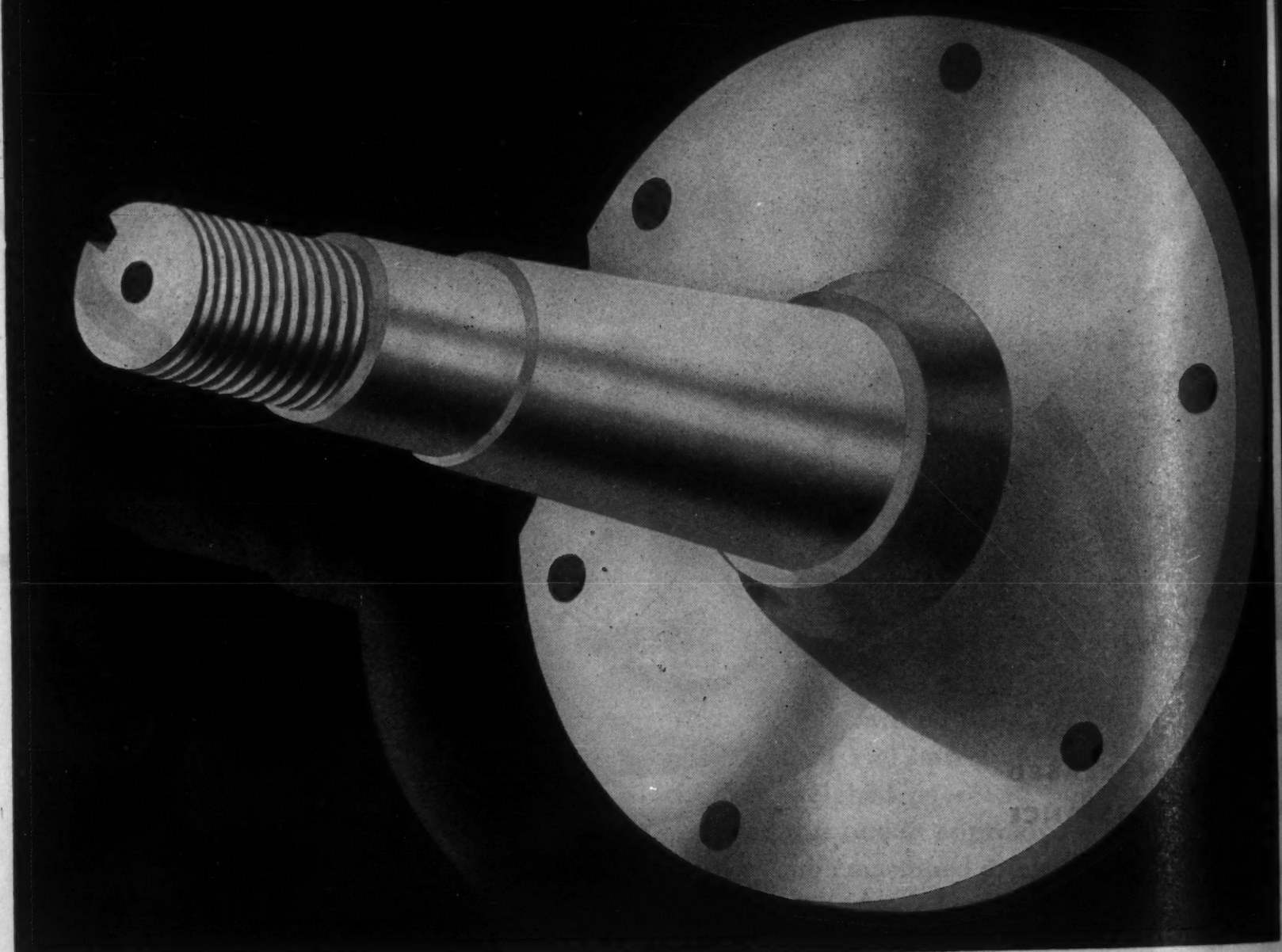
WHEN YOU NEED STAINLESS STEELS!

Telephone Industrial first . . . then receive *all* your requirements from the largest, most diversified warehouse stock of Stainless Steels in America. Industrial's huge inventory includes scores of different items in Stainless — that's why *same-day* attention to your order is assured. What's more, you are charged *no premium over mill prices*. Remember . . . if its Stainless, Industrial has it. And don't hesitate to call on Industrial's expert metallurgists if you have a problem concerning Stainless. Free catalog sent on request. Industrial Steels, Inc., 250 Bent Street, Cambridge 41, Mass. TROwbridge 7000.

Everything in STAINLESS

INDUSTRIAL STEELS, INC.

Molybdenum is an economical preventive of temper brittleness in steel.



CLIMAX FURNISHES AUTHORITATIVE ENGINEERING DATA ON MOLYBDENUM APPLICATIONS.

ARMY E NAVY

MOLYBDIC OXIDE, BRIQUETTED OR CANNED • FERROMOLYBDENUM • "CALCIUM MOLYBDATE"

Climax Molybdenum Company

500 Fifth Avenue · New York City

MOLY

Case histories *Prove*

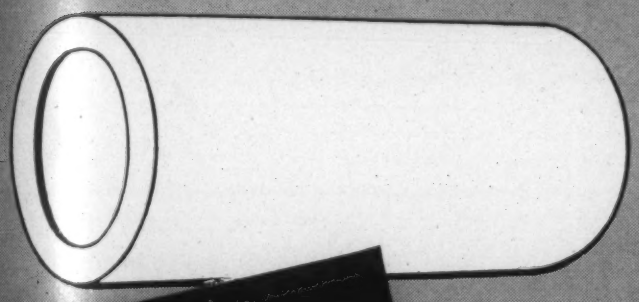
that AMPCO METAL lasts several times as long as ordinary bronzes

AMPCO Metal

★ avoiding costly breakdowns and production delays

★ meeting severe conditions of wear, impact, fatigue, corrosion

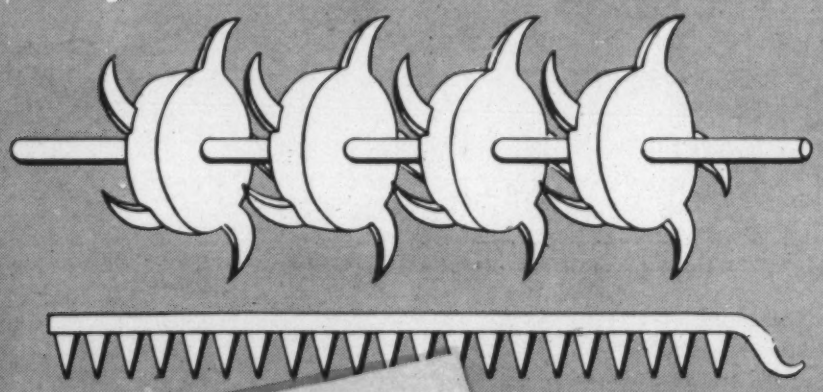
★ helping to give your equipment a reputation of dependability



Main bearings of heavy press last 15 months instead of three to six weeks

Case No. AC8-21

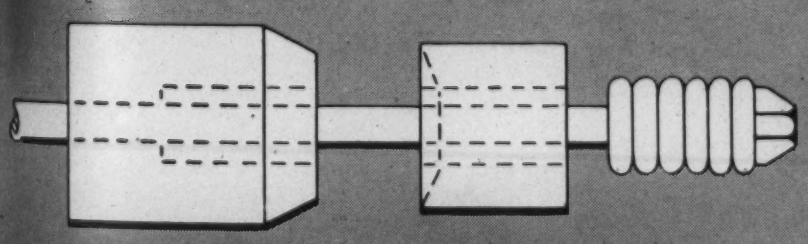
Operating at the unusual speed of 75 strokes per minute, this battery of presses incurred a dismantling cost up to $5000 per press every three to six weeks for replacement of main bearings, with a serious interruption of production. Substitution of Ampco, together with engineering recommendations for operating technique, resulted in bearing life of 15 months up to date of last report.



Life of "Wool-washer" parts increased 20 times

Case No. SF-16

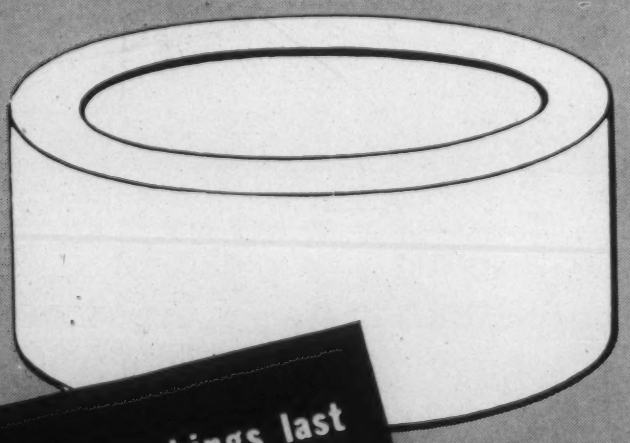
Finger for separating cotton fibres lasted about 20 times as long when Ampco was substituted for former material— with complete freedom from stains and rust spots. An Ampco spider ratchet in the drying machine lasted five times as long and likewise eliminated staining.



One-third less pressure required with Ampco guide bearing

Case No. MR-13

In broaching and sizing steel shell tubing, substitution of Ampco for steel, in the rod guide of the hydraulic press, permitted reduction of operating pressure from 1200 pounds to 800 pounds, with increased speed. Spoilage of bearings during heat treatment, formerly as high as 66⅔%, was eliminated.



Hydraulic bushings last three to four times as long

Case No. BM11-7

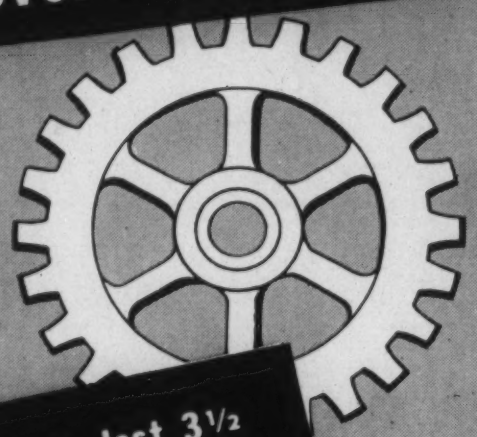
"2920 miles without a grunt and as good as the day they went in" is the user's description of the two-year service of these 24" bushings, used on a high-speed operation where former materials lasted from a few days to a few weeks or months.

. . . more case histories on next page

continued from preceding page

More case histories

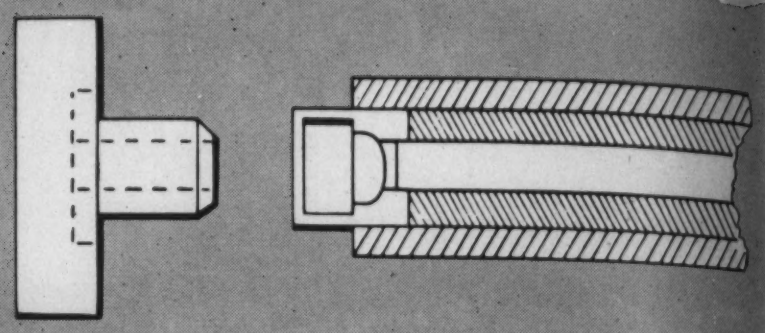
..further proving that AMPCO METAL lasts several times as long as ordinary bronzes



Worm gears last 3½ months — former life not over four weeks

Case No. 18-23

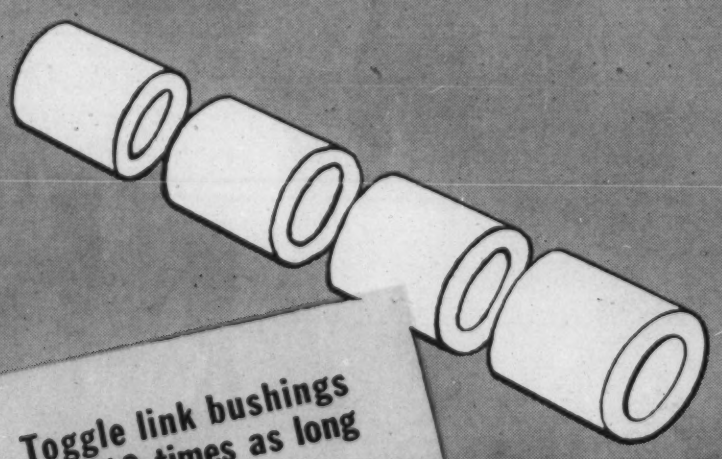
Worm-driven vertical mills in automotive application sometimes chewed up worm gears in one day; life seldom exceeded four weeks. Ampco gears still operating satisfactorily after 3½ months with no sign of failure.



Ampco die for hot-forming glass eliminates repeated failures

Case No. HC11-8

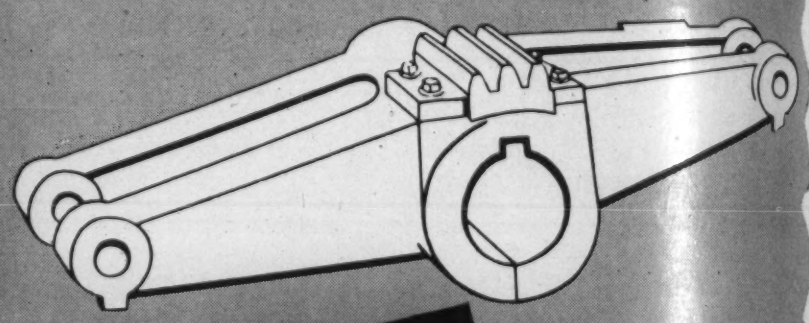
Due to the heat employed, former materials would wear, fail to hold an edge, and make it impossible to maintain required tolerances. Ampco dies stand up for 10,000 to 15,000 pieces with satisfactory results.



Toggle link bushings last 10 times as long

Case No. Jy4-1518

Former bushings for forging machines (operating 24 hours a day on shells) lasted three to five weeks, caused time loss of three days for each replacement. Ampco bushings installed as test showed no wear after nine months, now used regularly.



Gear segments, formerly good for six to eight months, now in use for more than two years

Case No. SL12-1

Severe conditions of heat, moisture, and vapor formerly caused these segments to fail after six to eight months. Ampco segments, after two years, show no sign of needing replacement.

Ampco's complete facilities make these advantages readily available to you . . .

The various grades and modifications of Ampco Metal make this aluminum bronze alloy an *engineered material* which can be matched closely to the conditions and requirements of *your* job. Ampco can fabricate the material by any or all of the commonly-used metalworking processes, in practically any size, shape, or degree of precision. Engineering service available — send us your prints or consult nearest Ampco field office. Ask for technical bulletins.

. . . Specialists in engineering — production — finishing of copper-base alloy parts.

AMPCO Metal
Reg. U.S. Pat. Off.
The Metal without an Equal

Ampco Metal, Inc.
Dept. MA-7
Milwaukee 4, Wis.
Ampco Field Offices in Principal Cities

Only from Ampco can you get all of these services and benefits conveniently:

1. Distinctive properties of resistance to wear, impact, fatigue, corrosion.
2. A series of engineered alloys — with physical properties to fit your application.
3. Quality control to hold these properties within narrow limits.
4. Diversified production facilities — coordinating in one place all the commonly used metalworking processes.
5. Engineering and production "know-how" to give you a practical manufacturing program.
6. A nation-wide organization of field engineers to assist you.
7. A record of proved performance in hundreds of leading makes of equipment.
8. A national reputation that makes Ampco Metal parts a sales asset.

AW-55

PERMANENT MAGNETS MAY DO IT BETTER

(This is the third in a series of four advertisements discussing the major functions of permanent magnets)

TRACTIVE EFFORT from PERMANENT MAGNETS

The power to attract magnetic materials led to the discovery of the lodestone—the earliest known form of permanent magnet. The same force has served mankind, since antiquity, in the compass. This tractive effort is now employed industrially in three ways.

1. *For holding and lifting magnetic materials.* Magnetic materials are held in place for assembly or other operations, by means of magnetic chucks or jigs. Magnetic separators extract tramp iron or other magnetic substances from non-magnetic materials. They function in such devices as coin selectors in vending machines.

2. *To produce tension*—replacing mechanical springs in various applications where tension in another form is required. This principle is used on thermostats, pressure controls, switches, and similar devices.

3. *To transmit motion without mechanical connections.* Permanent magnets can reproduce motion from one part to another through a seal—as in the flow meter and other packingless drives.

Indiana Steel is the largest exclusive manufacturer of permanent magnets, established for over 35 years. Without obligation, our engineers will be pleased to consult with you on any of your problems involving their possible application. Write for copy of technical booklet: "Permanent Magnets Have Four Major Jobs."

THE INDIANA STEEL PRODUCTS COMPANY

6 NORTH MICHIGAN AVENUE • CHICAGO 2, ILLINOIS

ARMY E NAVY *Specialists in Permanent Magnets Since 1910*

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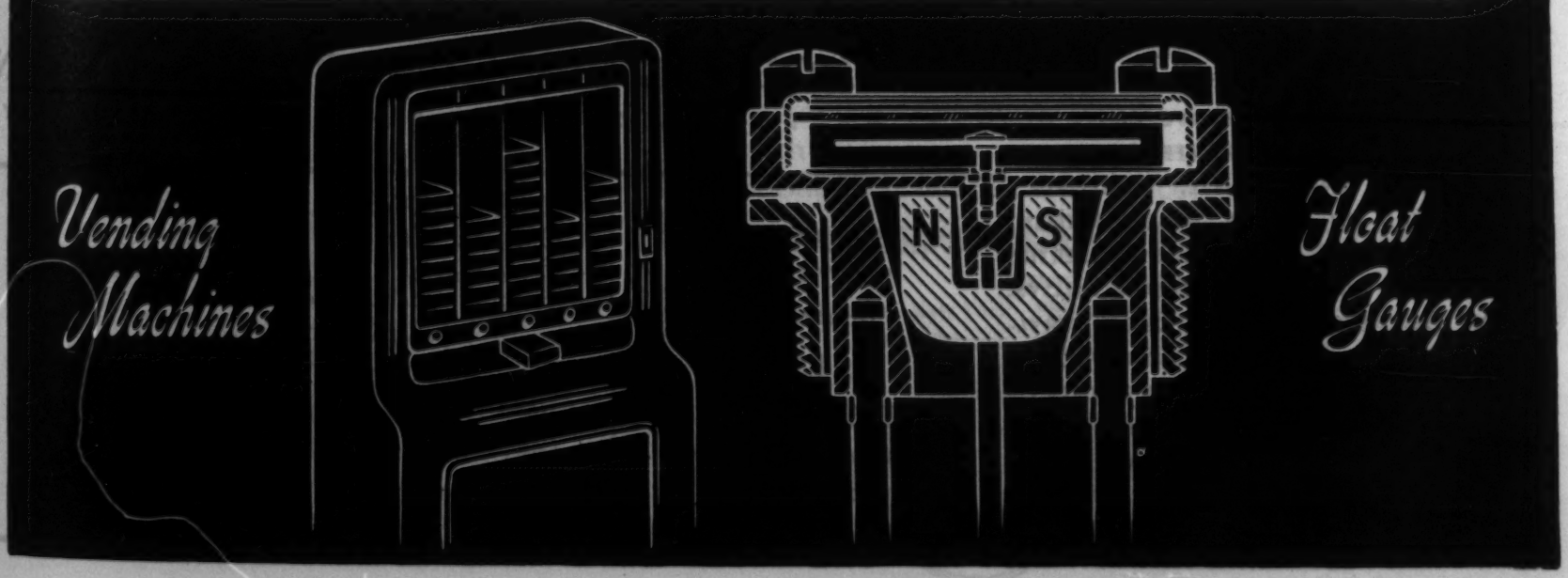

HARDNESS. CORROSION RESISTANCE.
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CAST IRON. MALLEABLE CAS
MINUM AND COPPER ALLOY
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TANTALUM, ETC. RARE METALS. ROCKW
SCALES. VALVES AND VALVE-SEAT
RIAL. HOT HARDNESS OF TOOL
STEELS. JUDGING TEMPERATURE
FREE CUTTING STEELS. NICKEL
EL-CHROMIUM STEELS. MOLYP
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OF MONEL. ZINC AND ZINC-BASE ALLOYS.
ZINC DIE-CASTING ALLOYS. FORGED BERYL-
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TIES OF THE ELEMENTS. MELTING POINTS OF
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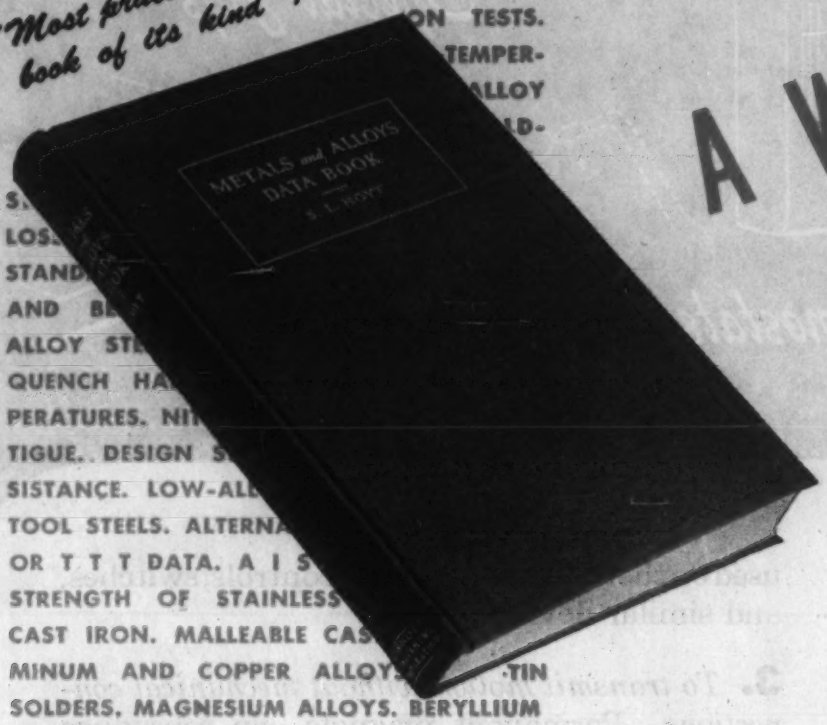
WEIGHTS AND AREAS OF SQUARE AND
ROUND BARS. CONVERSION FACTORS. TEM-
PERATURE CONVERSION TABLE. PROPERTIES

"Most practical, complete and informative book of its kind . . . ever published"



Here Is

A WORKING GUIDE

to the Properties of All

INDUSTRIAL METALS AND ALLOYS

METALS and ALLOYS DATA BOOK

By SAMUEL L. HOYT

Technical Advisor of Battelle Memorial Institute
Formerly Research Metallurgist for General Electric Co.

The first complete one-volume collection of authenticated data on metal properties.

"A usable book for ready reference, filled with practical working information, graphically presented in a series of well organized tabulations. It contains the latest, most authoritative data on all the industrial metals and their alloys."

The Data Book contains 340 tables of critically evaluated data on wrought and cast steels, stainless steels, cast irons, heat- and corrosion-resistant casting alloys, aluminum, copper, nickel and tungsten alloys and rare metals; offers the most recent information on all their important properties—tensile strength, hardness, thermal expansion, creep strength, high-temperature behavior, work-hardening, endurance limit, and yield strength—to mention only a few.

The Data Book is invaluable for Design, Materials, Mechanical, Metallurgical and Chemical Engineers; Research Men; Engineers, Inspectors, and others in shop, mill, or in the field, producing, designing, fabricating or otherwise using metals, alloys or metal products.

Dr. Hoyt, by eliminating descriptive text and concentrating on authenticated data has succeeded in covering even the large metals and alloys field in this one volume. All figures given are the latest available at the time of publication.

In an admirable preface Dr. Hoyt clearly explains how the values should be interpreted and how closely they are related to actual performance expectations.

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$4.75

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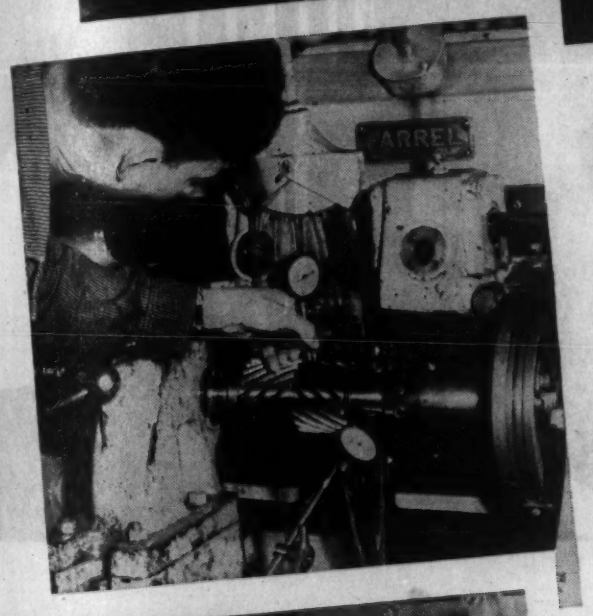
There's an improvement

in production, tool life, and finish

when the proper Gulf Cutting Oil is used!

Aircraft Supercharger Impellers

Gulf Cut-Aid proved superior to twelve other brands of cutting oil tested in this plant for straddle milling aluminum alloy supercharger impellers. With this revolutionary new cutting oil, production is 10% greater and tool life 50% longer than with cutting oil previously used.



Helical Gears

The use of Gulf Cutting Oils on this gear generator led to a 20% increase in cutting speed, 25% greater tool life, and improved production.

Shell Adapter Rings

When the proper Gulf Cutting Oil was put in service on this big automatic, rejects were reduced to a negligible percentage, tool life was greatly increased, and bearing trouble was eliminated.

AGAIN AND AGAIN, on the most exacting war assignments, Gulf Cutting Oils have made outstanding improvements in production and tool life. Call in a Gulf Service Engineer today and let him show you how they can help you with *your* machining problems. Write, wire, or phone your nearest Gulf office.

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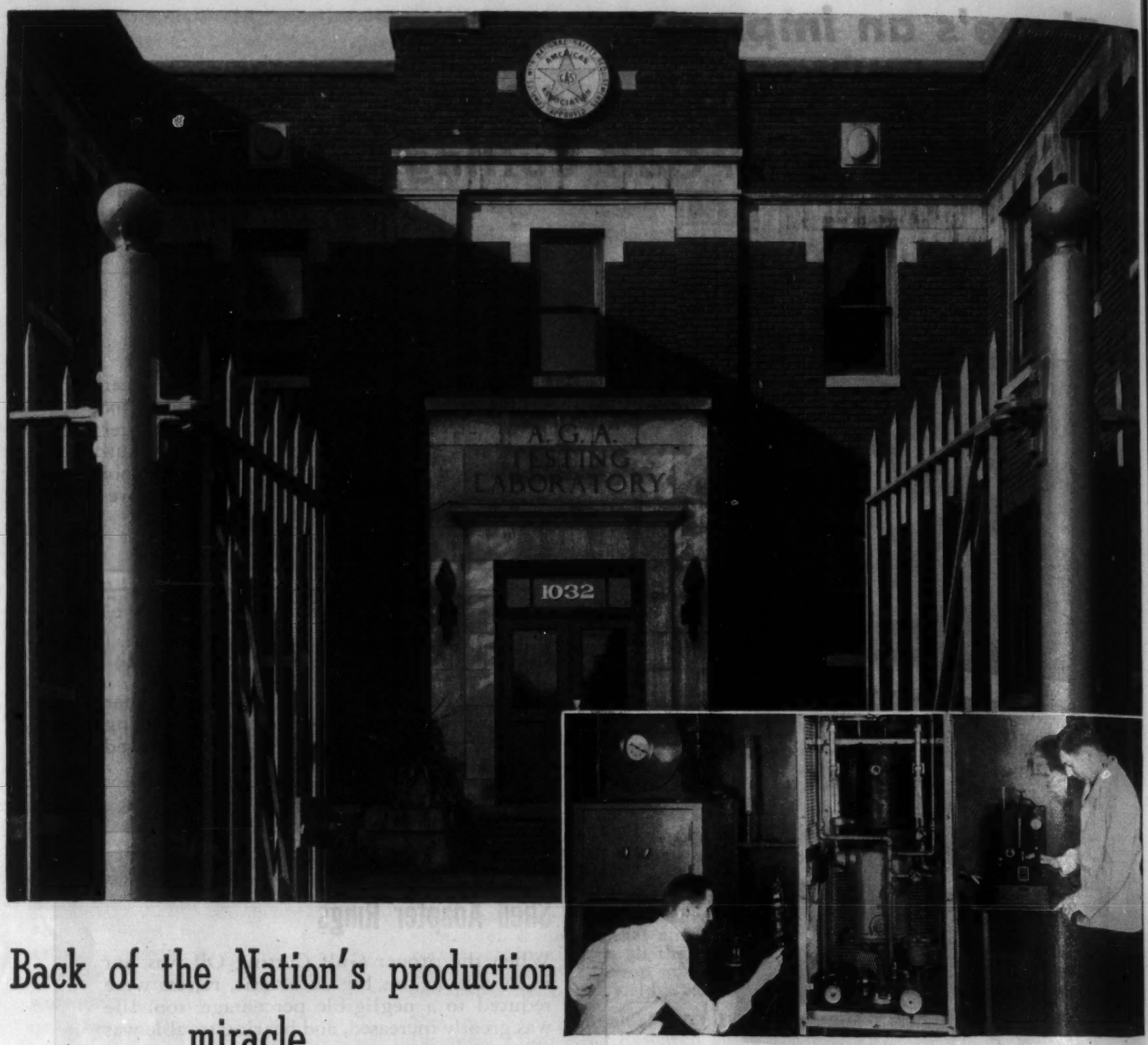
GULF INDUSTRIAL LUBRICATION



Back of the Nation's production miracle . . .

Gas Research

When a new production problem comes up—and plenty have come up since the war began!—it often has developed that the answer already has been found by the designers and builders of Gas furnaces through research and experiment already done.

In addition to all the other progress in the industrial heating field, the Gas industry itself has for years been engaging steadfastly in research in its own Laboratories, in university laboratories, and in the laboratories and shops of Gas equipment manufacturers . . . and some of the results obtained are today helping to win the war—through better Gas equipment which is speeding production of armaments made of all types of ferrous and non ferrous metals and their alloys.

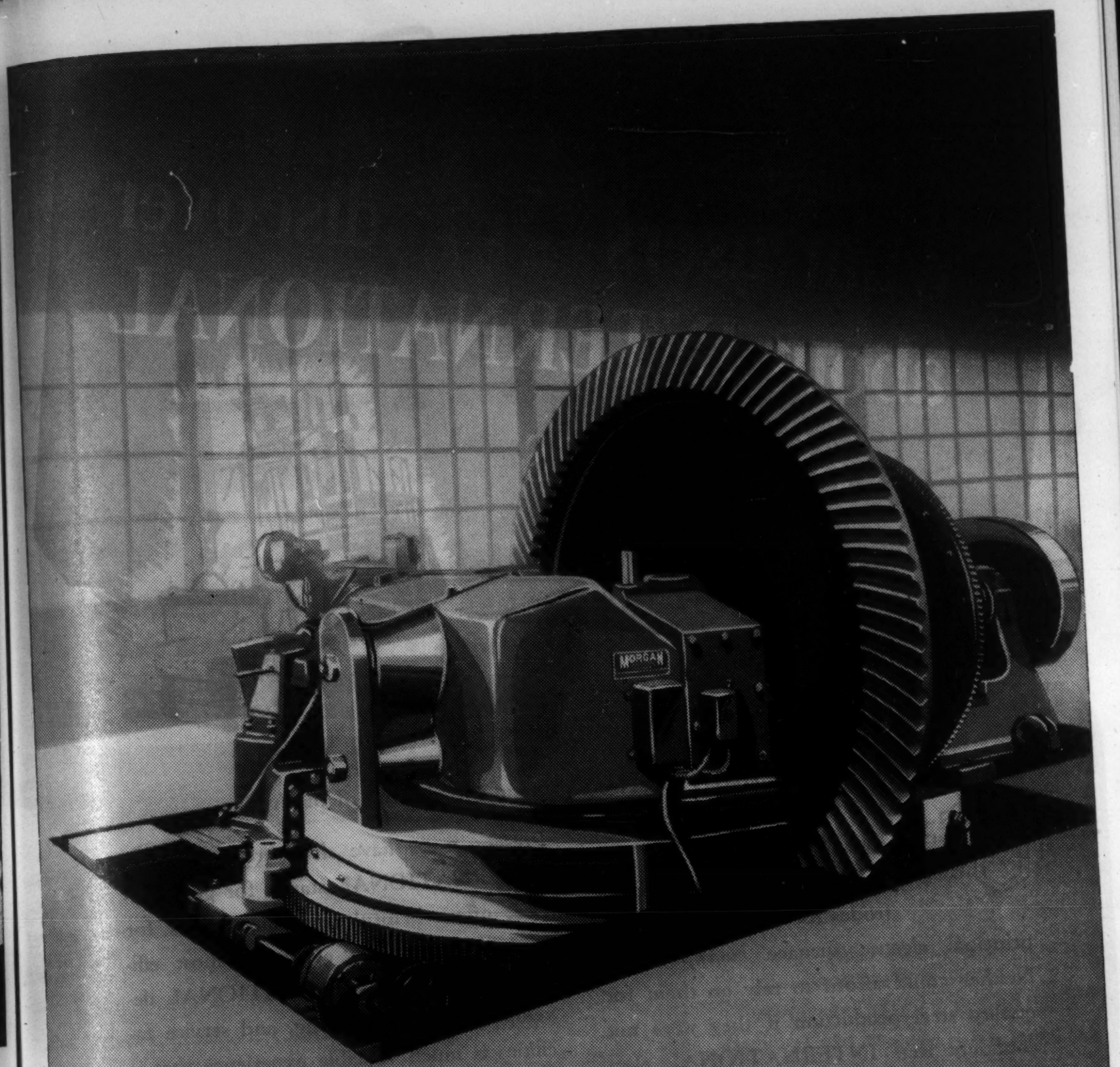
Busier than ever before, our Gas laboratories are almost completely devoted to war research . . . but the shortcuts to better products at constantly lowered unit costs are of intense interest to every manufacturer of post-war goods.

Ask your Gas company to keep you fully informed on new Gas techniques for reconversion and post-war application.

BUY WAR BONDS—HELP SPEED VICTORY!

AMERICAN GAS ASSOCIATION
INDUSTRIAL AND COMMERCIAL GAS SECTION
420 LEXINGTON AVENUE, NEW YORK, 17, N.Y.

THE TREND IS TO GAS
FOR ALL
INDUSTRIAL HEATING



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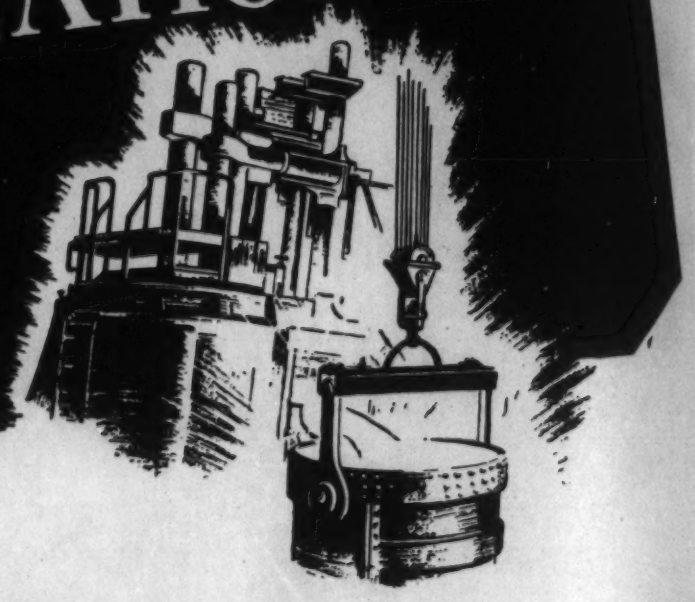
English Representative: International Construction Co., 56 Kingsway, London, W. C. 2, England

what users discover about INTERNATIONAL electrodes



Leading *producers of* electric furnace steels have been consistent users of INTERNATIONAL Graphite Electrodes for 15 years. So have principal electric furnace *manufacturers.* Neither could afford to rely on them for quality steel production if they were not confident that INTERNATIONAL electrodes fully measure up to every important standard by which acceptable electrodes are judged.

Users have proved this fact to their own satisfaction in the severest test of all—in actual furnace operation under a wide range of production requirements. Thus, they have found that INTERNATIONAL electrodes can be depended upon to have all the physical, electrical and chemical properties essential to maximum service, at minimum cost per ton of production.

Present users have discovered, too, that INTERNATIONAL stands for good service; offers helpful recommendations for applying and using electrodes most efficiently. Behind INTERNATIONAL development, manufacturing, and service facilities is much valuable experience that is yours for the asking. Write us for additional details.

International Graphite & Electrode Corp.

SAINT MARYS, PA.

7373

Cyanamid's AEROHEAT*

1000–1200

Non-Decarburizing Heat-Treating Salt Baths

DO ✓	DO NOT ✓
• INCREASE POT LIFE	• DECARBURIZE
• AND ELECTRODE LIFE	• SLUDGE
• DECREASE OPERATING COST	• CHANGE VISCOSITY

DEPENDABLE...EFFECTIVE...ECONOMICAL

Introduced to the metal treating industry only a year ago, Cyanamid's AEROHEAT Heat-Treating Baths have *established by performance* their dependability . . . efficiency and economy of operation. Our technical staff and research laboratories are prepared to work with you to help solve problems relating to case-hardening, carburizing, or heat-treating. Complete details on the physical properties, uses and operating characteristics of Cyanamid's AEROHEAT compounds are available in special data sheet folder.

"When Performance Counts . . . Call on Cyanamid"

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(A Unit of American Cyanamid Company)

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Send for data sheet folder on above products

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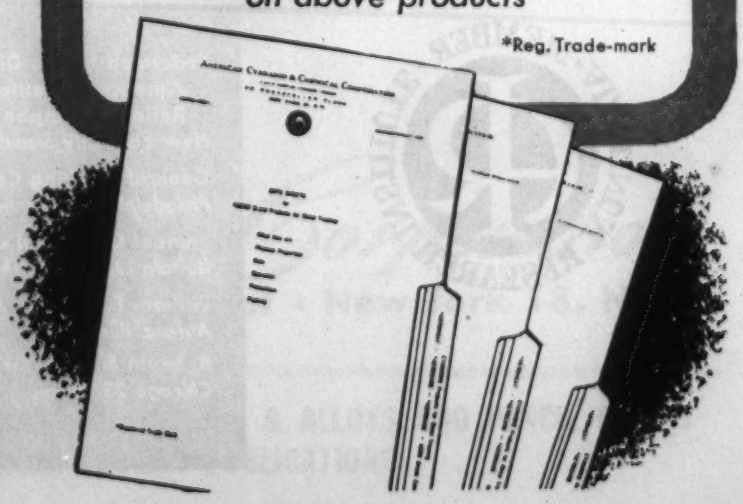

THE PERFECT CASTING

The Perfect casting would be the result achieved where every factor in the foundry functioned ideally; that is, perfect metal, perfect temperature controls, perfect sand, perfect molds, perfect cores, and perfect skill.

But, if everything at the foundry were perfect and the metal did not meet the most rigid of specifications, perfection could not be approached.

Good foundrymen are constantly striving to attain the perfect or ideal casting. That is why it is important to start with Aluminum Alloy ingot produced by Smelters whose constant aim is the closest possible approach to the Perfect.

We use the most up-to-date, scientific methods of control in the production of our ingot to assure foundrymen of the meeting of the exact specifications called for. The production of this quality metal is our role in the striving for The Perfect Casting.

ALUMINUM RESEARCH INSTITUTE

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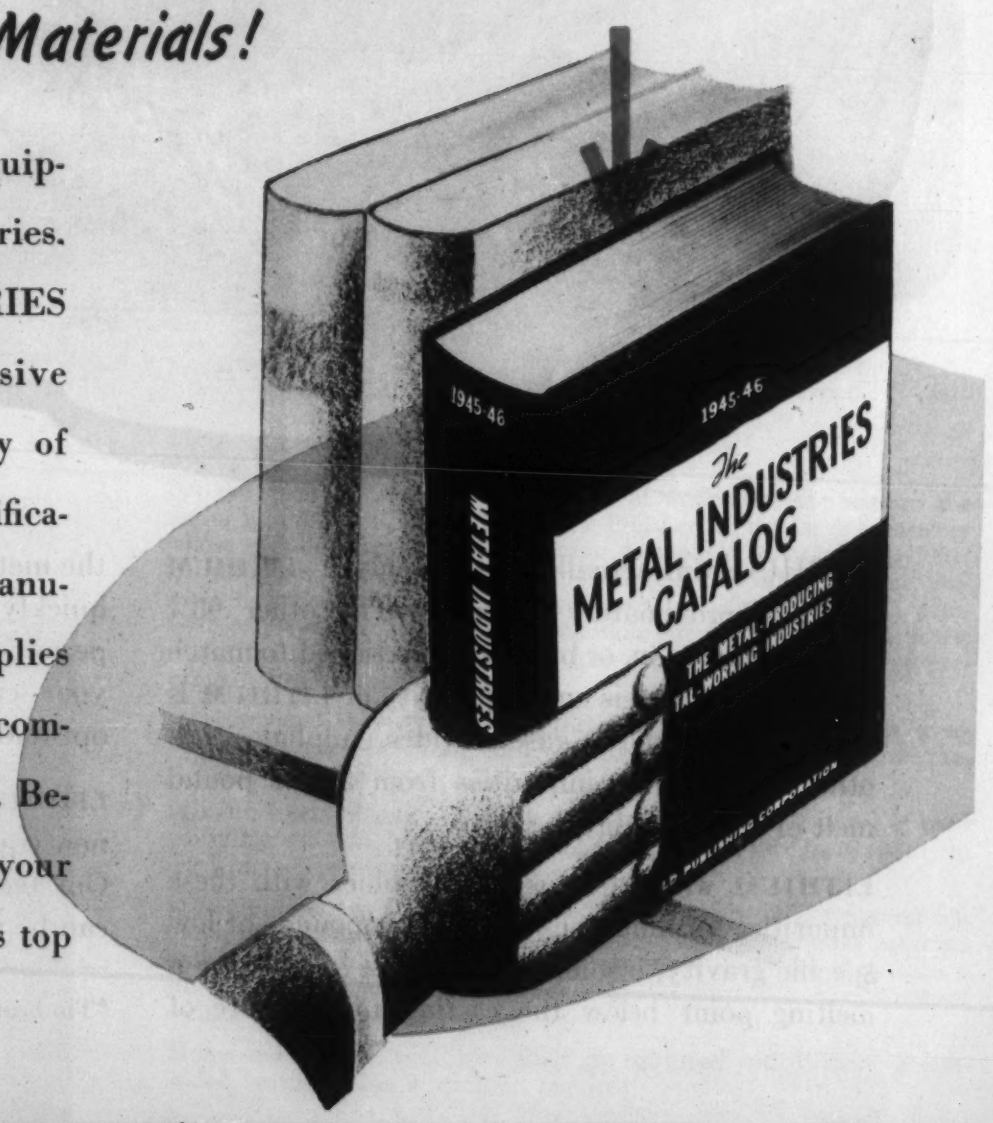

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THIS chunk actually contains only 2% **LITHIUM** — approximately ½ ounce. The other 98% consists of Cu, Zn, or bronze proportioned to match your melt. Yet this small quantity of **LITHIUM** is sufficient to remove gases, oxides, sulphides and other non-metallic impurities from a 200 pound melt of copper or bronze.*

LITHIUM works because it combines with these impurities forming non-metallic compounds of low specific gravity, insoluble in the melt and having a melting point below the casting temperature of the metal. These compounds volatilize, or flux out quickly, thus increasing the fluidity which often permits lowering pouring temperature. As a result, your castings are clean and sound, possessing optimum physical characteristics.

LITHIUM treatment requires no new technique, no new equipment, no special training for your crew. Our technical staff and our own casting facilities can be placed at your disposal.

*Tin bronze or silicon bronze.

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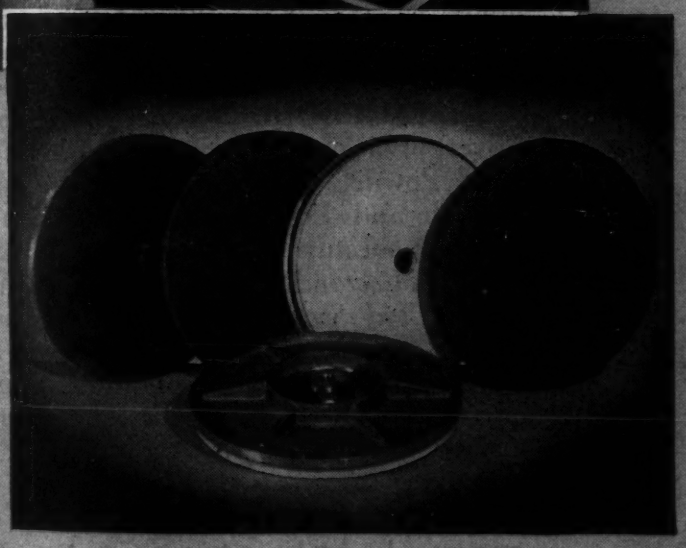
PRECISION METALLURGICAL SPECIMEN POLISHER

PATENT PENDING

Employs advanced "Grind-Polish" principle—interchangeable laps—standardized polishing solutions—easy-to-clean—smooth-running, quiet operation—for better work in less time.

Equally suited to installation on top of table, or as shown at the left, suspended by means of overhanging flange, flush with table top. Easy to keep clean. Built for many years of rugged service.



Four interchangeable polishing laps comprise a 500-grit stone, levigated alumina, canvas or wax-impregnated cloth, pressed felt. Note thickness and under-structure of metal backing, perfectly rigid, flat, and vibration-free.

For the small laboratory whose volume of work does not warrant the use of a "Precision-Jarrett" Automatic Polisher, or the large laboratory whose metallurgical inspection routine demands a series of individual polishing units, this new "Precision" Single-Unit Metallurgical Polisher nevertheless utilizes the fundamental "Grind-Polishing" principle employed in the advanced "Precision-Jarrett" Automatic Polisher, using the same series of interchangeable laps and succession of prepared polishing solutions.

Self-contained cabinet, sturdily built of rust resistant steel, has overhanging flange permitting flush mounting suspension in a table top, if desired, as illustrated.

Stainless steel polishing pan with drain for continuous removal of used polishing solution, permits washing of laps and specimens with no need for a separate sink.

Laps are driven at 172 R.P.M. by a ¼ H.P. heavy-duty motor on felt mounting. Silent, smooth operation, free from vibration, is achieved by a unique method of coupling the motor to the drive shaft thru a worm and gear combination which does not employ a metal-to-metal contact between lap and motor.

Motor and stainless steel drive shaft are equipped with lifetime grease-sealed bearings. No lubrication required.

Exterior finish is baked-on Kem-Resist, easy to clean and keep clean, and a stainless steel cover is included to shut out dust and dirt when the machine is not in use.

Write for detailed Bulletin 850-F on Metallurgical Apparatus.

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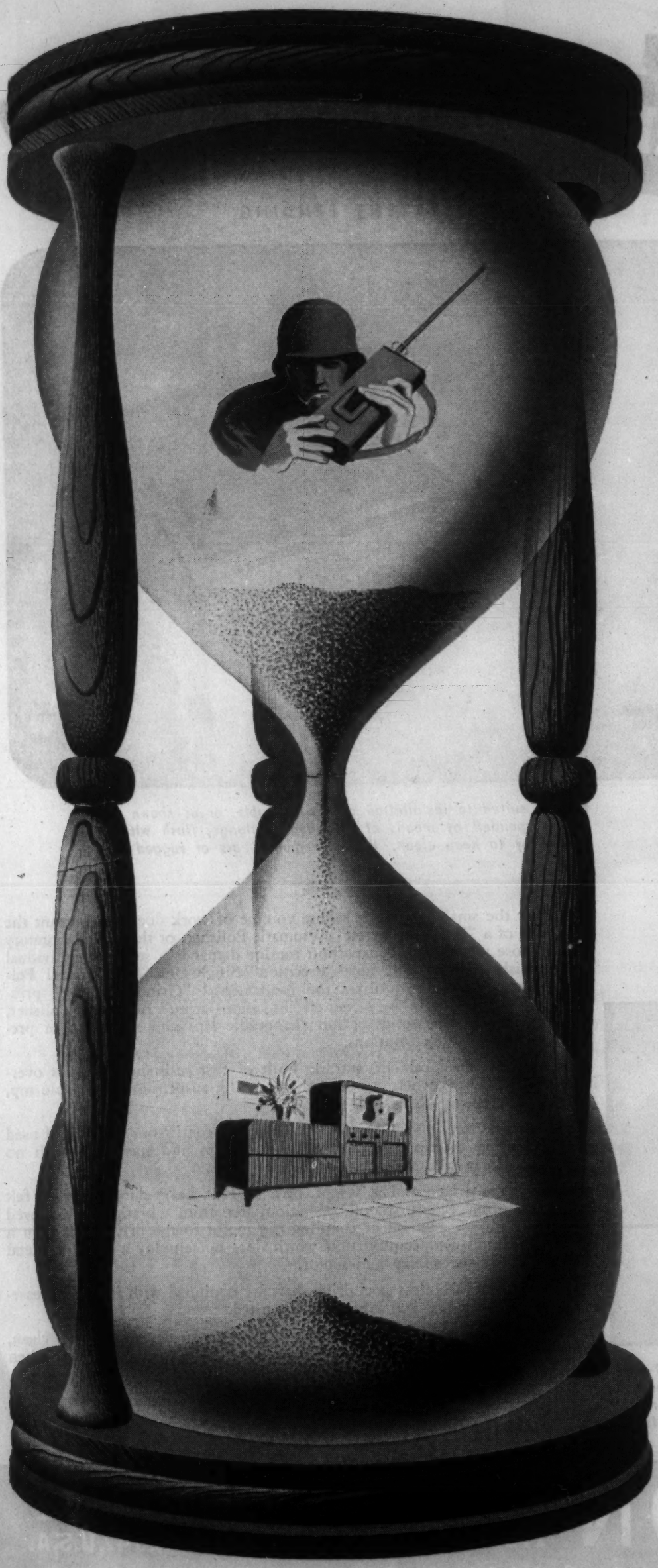
Engineers and Builders of Scientific Apparatus and Production Control Laboratory Equipment for Almost a Quarter Century



Every MANUFACTURING CUSTOMER Will Benefit

Industrial users of WILCO Products will find the increased facilities, the new products and techniques developed by WILCO for war service of great advantage to their own postwar products.

As the Hourglass indicates . . . with the coming of peace, many WILCO products now making for precision performance in airplanes, ships, tanks, guns and instruments of the Army and Navy will play an equally important role in meeting civilian needs for hundreds of useful and reliable products.

The demand of all branches of the service for Thermostatic Bimetals and Electrical Contacts has motivated many WILCO developments of great potential value to post-war industry. New products added to an already extensive line; increased facilities for refining and fabricating precious metals; greatly extended rolling mill facilities—these new additions and improvements, now devoted principally to the war effort, will prove equally helpful to manufacturing customers in meeting their peacetime production and marketing problems.

WILCO PRODUCTS ARE: *Contacts*—Silver, Platinum, Tungsten, Alloys, Sintered Powder Metal. *Thermostatic Bimetal*—High and Low Temperature with new high temperature deflection rates. *Precious Metal Collector Rings* for rotating controls. *Silver Clad Steel* for bearings, shims, reflectors. *Jacketed Wire*—Silver on Steel, Copper, Invar, or other combinations requested. Rolled Gold Plate. Special materials.

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TO THE MARITIME INDUSTRY

FOR

Distinguished Service

The reply of American industry to the challenge of Brutalitarianism has been a deluge of production never before achieved by any nation in the history of mankind.

A significant share of the credit for this amazing record of accomplishment should be given to our Maritime Industry which, since Pearl Harbor, has produced a tonnage of vessels that will live forever as an epic of Yankee ingenuity. Federated is proud to salute every individual in the Maritime Industry for this magnificent job!

And proud, too, that since the start of the war, nearly two billion pounds of Federated non-ferrous metals have been supplied to the shipbuilding and other American industries to help speed the day of ultimate victory.

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FMD AMERICAN SMELTING & REFINING COMPANY

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Nation-wide service with offices in principal cities

ONE OF A SERIES OF ADVERTISEMENTS DEDICATED TO THE PRODUCTIVE ROLE OF AMERICAN INDUSTRY IN WORLD WAR II.

This RUST Prevention Program may save you $10,000 too!

Manufacturer salvages 12,000 Ballistic Dies . . . protects further production with ANTI-CORRODE

A complete plant rust-prevention program is certain to insure operating economy and accelerate production. Backed by a complete line of tested Anti-Corrodes for every industry, Cities Service engineers are prepared to study *your* rust problems and recommend a specific plan to eliminate them.

Here's an Example . . .

A Bloomfield, N. J., manufacturer of ballistic dies had a costly problem. After partial completion, his dies were boxed, then shipped to another plant for final treatment. The dies invariably rusted so badly during return transit that they actually would stick together. 12,000 in this condition had accumulated in the plant, representing an investment *in labor alone* of eight to ten thousand dollars.

Cities Service engineers were called in. They supplied a product to clean the defective dies quickly . . . specified a special grade of Cities Service Anti-Corrode to protect them in storage. Three months later the dies were accepted for completion by the final processor. All dies thereafter were immediately dipped in this Anti-Corrode. The rust problem was licked.

Performance records such as this are being chalked up every day by Cities Service engineers in every industry — Mining, Textile, Metal-Working, Construction and others.

See what Cities Service can do for you. Call in our engineers now. Contact your local Cities Service office or mail this coupon.

ANNUAL RUST TOLL CONSERVATIVELY ESTIMATED AT $100,000,000 . . . All metals when exposed to the elements have an inherent tendency to revert to one or another of the forms in which they were originally found in the earth. Iron rust is the most common example of this action. Best safeguard for *your* equipment is a carefully planned and followed Rust-Prevention program.

ANTI-CORRODE safeguard for Industry

CITIES SERVICE OILS — ONCE-ALWAYS — YOUR SYMBOL OF SERVICE

Cities Service Oil Company
Room 326, 70 Pine Street, New York 5, N. Y.
Gentlemen: Please have your engineers discuss with me a program of rust-prevention for our plant. (No obligation, of course.)

Name.....

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'SURFACE' ACHIEVEMENTS IN THE SCIENCE OF GAS CHEMISTRY AND HEAT TREATING

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STANDARD AND SPECIAL INDUSTRIAL FURNACE EQUIPMENT FOR:

Forging, Normalizing, Annealing, Hardening, Drawing (Direct-fired and Convection), Carburizing, Nitriding and Heating. Special Atmosphere Generators. *Write for bulletins.*

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NEW TREATMENT MAKES FERRO SILICON ALMOST NON-GASSING

You already know that specifications on gassing characteristics of Ferro Silicon have tightened up considerably in the last few years. Processes aimed at the ultimate goal of making Ferro Silicon non-gassing have greatly improved. However, to reach any comparative degree of efficiency, proper selection of raw material and a coarse grind were needed.

GUARANTEE ON GASSING COMING!

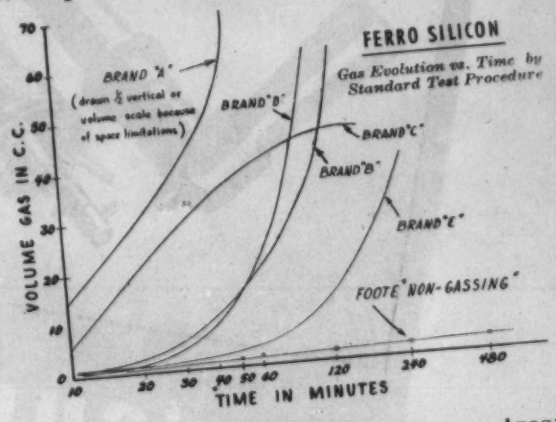
Foote now reports the successful completion of a new process which not only reduces gassing but *controls* the reduction! Very soon Foote will add a guarantee on percentage of gassing to its present chemical and screen guarantees.

NEW TREATMENT MORE EFFICIENT

The efficiency of the new process is ably demonstrated by the accompanying chart and the following comparison:

Gassing Evolved in 60 mins.

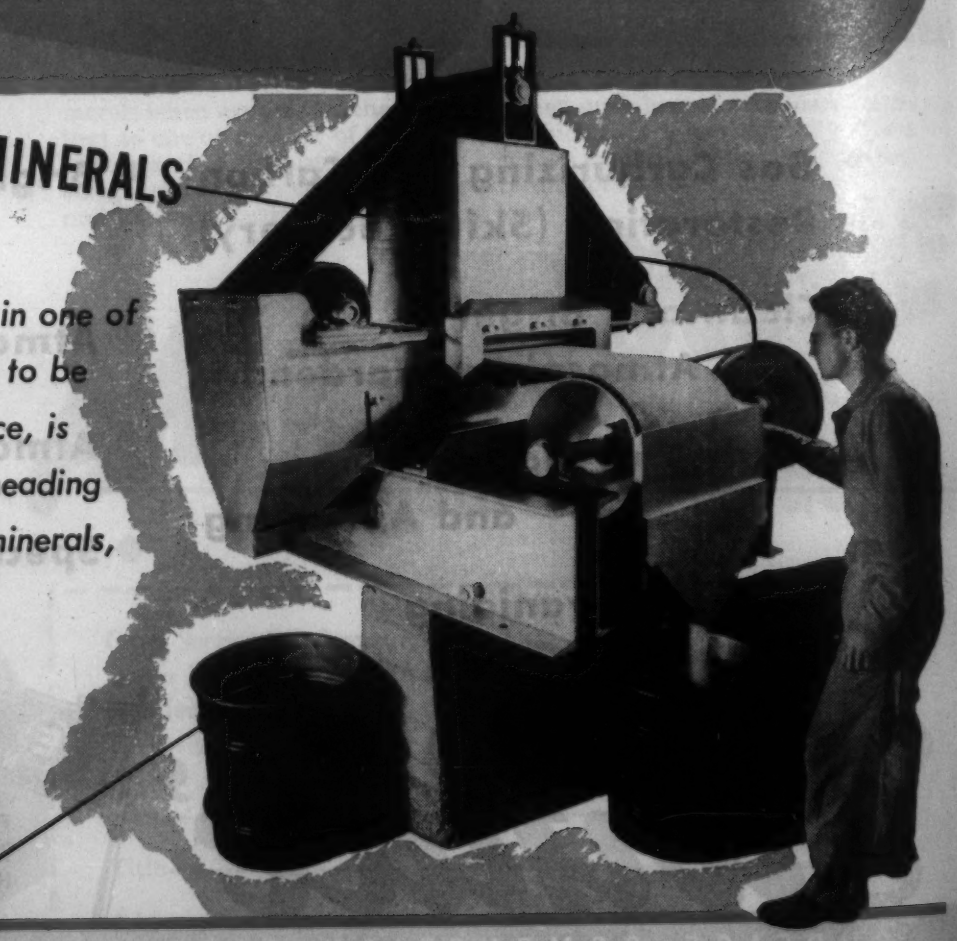
1. Untreated Ferro Silicon. 159 ccs.
2. Old treatment. 40 ccs.
3. Improved treatment. 2 ccs.



The chart proves that Foote's new treatment removes gassing regardless of the time the slug may be held in storage. It does not merely stabilize for a temporary period of time.

For information on Foote Ferro Silicon, write, wire or telephone at once.

THIS DIVORCES ORES AND MINERALS



Discharge end of a magnetic separator in one of the Foote plants. This machine, believed to be one of the largest of its type in existence, is typical of the modern equipment spearheading Foote's experience in processing ores, minerals, alloys and chemicals.

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What Depth do You Want?

7 FT. 15 FT. 25 FT. 50 FT. ?

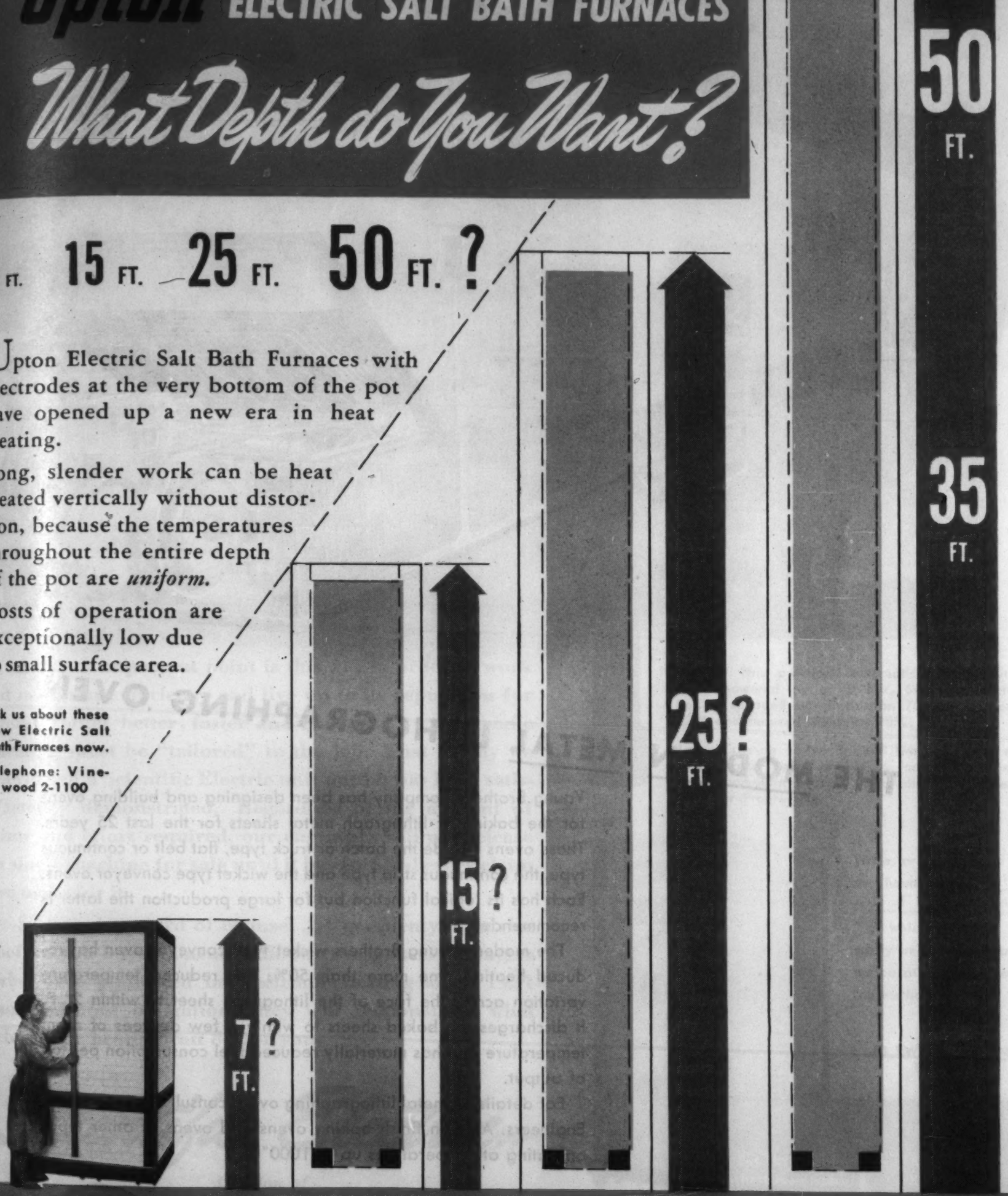
Upton Electric Salt Bath Furnaces with electrodes at the very bottom of the pot have opened up a new era in heat treating.

Long, slender work can be heat treated vertically without distortion, because the temperatures throughout the entire depth of the pot are *uniform.*

Costs of operation are exceptionally low due to small surface area.

Ask us about these new Electric Salt Bath Furnaces now.

Telephone: Vinewood 2-1100



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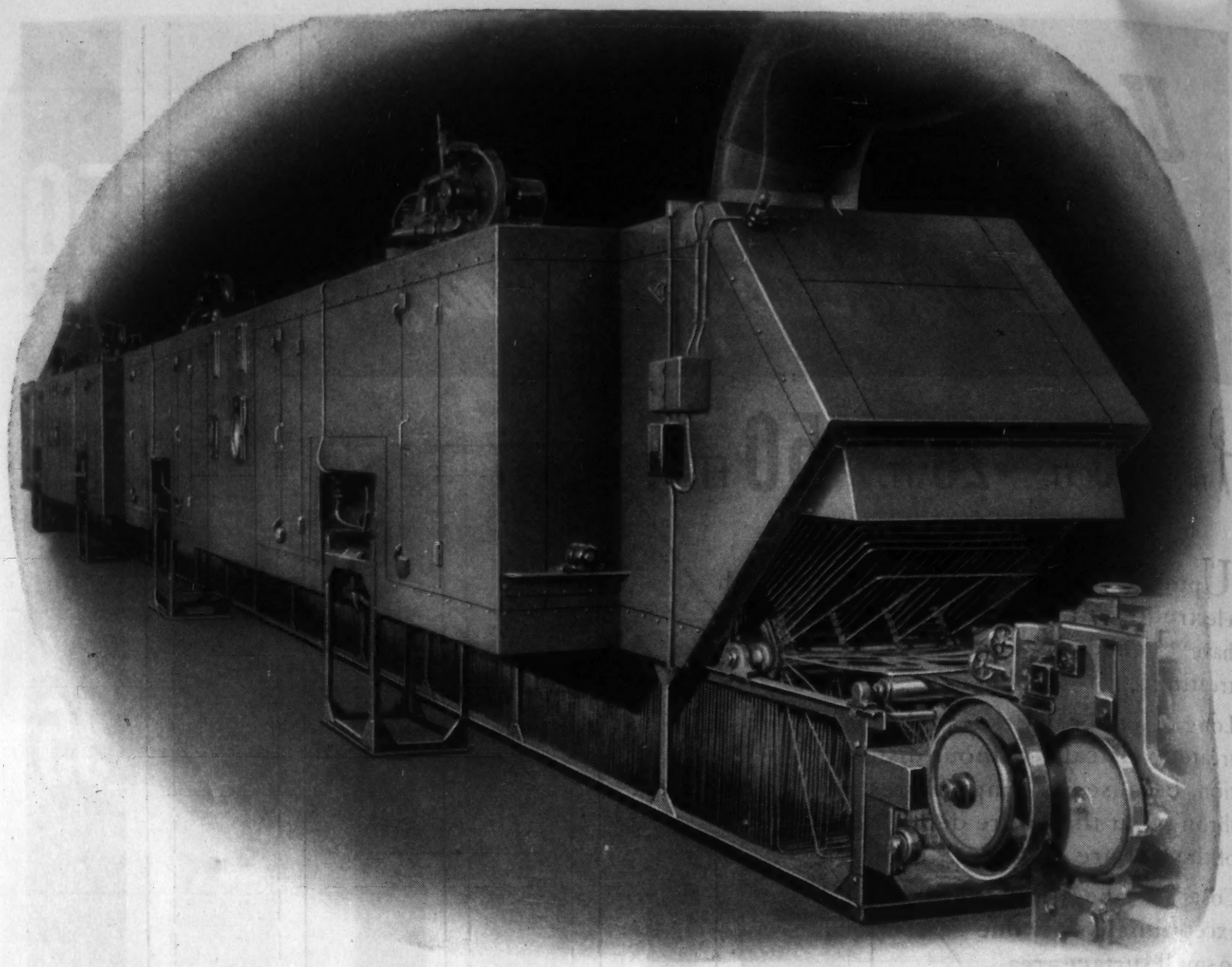

THE MODERN METAL LITHOGRAPHING OVEN

Young Brothers Company has been designing and building ovens for the baking of lithograph metal sheets for the last 25 years. These ovens include the batch or truck type, flat belt or continuous type, the continuous strip type and the wicket type conveyor ovens. Each has its logical function but for large production the latter is recommended.

The modern Young Brothers wicket type conveyor oven has reduced heating time more than 50%; has reduced temperature variation across the face of the lithograph sheet to within 2° F. It discharges the baked sheets to within a few degrees of room temperature and has materially reduced fuel consumption per ton of output.

For details on metal lithographing ovens consult Young Brothers Engineers. Also on finish baking ovens and ovens of other types operating at temperatures up to 1000° F.

YOUNG BROTHERS COMPANY

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YB CO

ESTABLISHED IN. 1896

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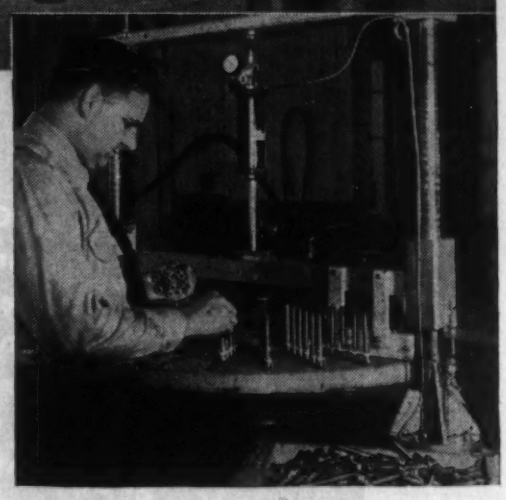
before you buy an Electronic Heater

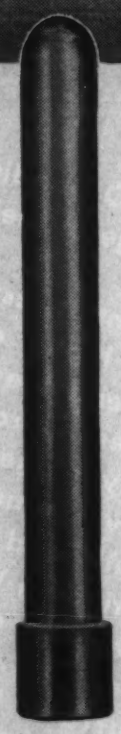
This is how Scientific Electric proved the value of electronic heating to the Progressive Welding Company of Norwalk, Connecticut . . .

GREAT improvements in product quality and remarkable savings in time and money are being achieved by means of electronic heating. Industrialists everywhere are now acclaiming its many advantages. But don't let your enthusiasm lead you to invest in an electronic heater before you have seen it perform the work you expect of it.

Another important point is this . . . in order to work at maximum efficiency and live up to its reputation for doing things better, faster and cheaper . . . electronic heating must be "tailored" to the job. That is why we never sell a Scientific Electric unit until it has been satisfactorily demonstrated. Regardless of the amount of time and effort required, our engineers will not release a single machine for sale until it has fulfilled every claim we make for it.

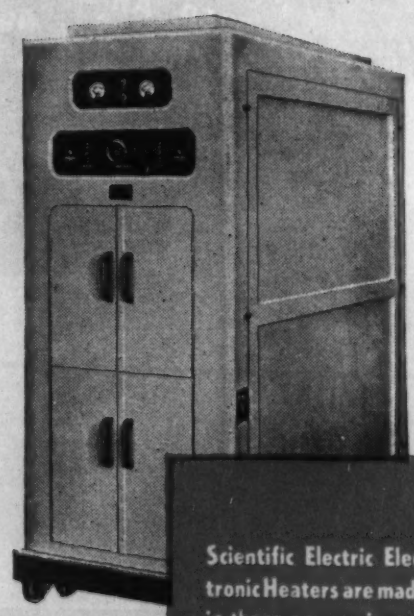
So here is a word of counsel . . . get plenty of advice before you buy. Consult with our recognized engineers who have pioneered in electronic heating since 1921 and, without obligation, they will demonstrate what electronic heating can do for you.





Above: This practical, automatic brazing turntable powered by a 40 KW. Scientific Electric heater speeded up production 700%—cut costs 87% and reduced rejects by 90%.

Left: Close-up of the finished two-piece tube assembly after being brazed by induction heating. Three complete brazing installations have been built for Progressive.



Write for a free copy of our handbook . . . *The ABC of Electronic Heating* which contains an easily understood explanation of this new heating method.

40 KW INDUCTION HEATER

Scientific Electric Electronic Heaters are made in these power sizes... and a range of frequencies up to 300 Megacycles depending upon power requirements.	3 KW	18 KW
	5 KW	25 KW
	7½ KW	40 KW
	8 KW	60 KW
	10 KW	80 KW
	12½ KW	100 KW
	15 KW	250 KW

Scientific Electric

Division of

"S" CORRUGATED QUENCHED GAP COMPANY

119 MONROE ST. GARFIELD, N. J.

Manufacturers of

Vacuum Tube and Spark Gap Converters Since 1921

That's Right, Mr. Jones...

Add 48 Minutes to each 8-hour shift

Switch to ELECTRO Grinding Wheels.
Take advantage of their 10% faster cutting.
Maybe more!

Revive the enthusiasm of your operators. They'll like the higher cutting speed, the uniform and dependable quality, the reduction of dressing. Less vibration and cooler-cutting are added advantages.

They'll have immediate confidence in the great strength and rugged construction of ELECTRO Grinding Wheels.

If you want to crowd 10% more cutting minutes into your 8 hour shifts, phone Buffalo, N. Y., WAshington 5259. An ELECTRO Engineer will be on his way right quick, to show you how to do it.

Electro
TRADE MARK
SINCE 1919

K-304

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Manufacturers of Crucibles • Refractories • Stoppers • Alloys • Grinding Wheels

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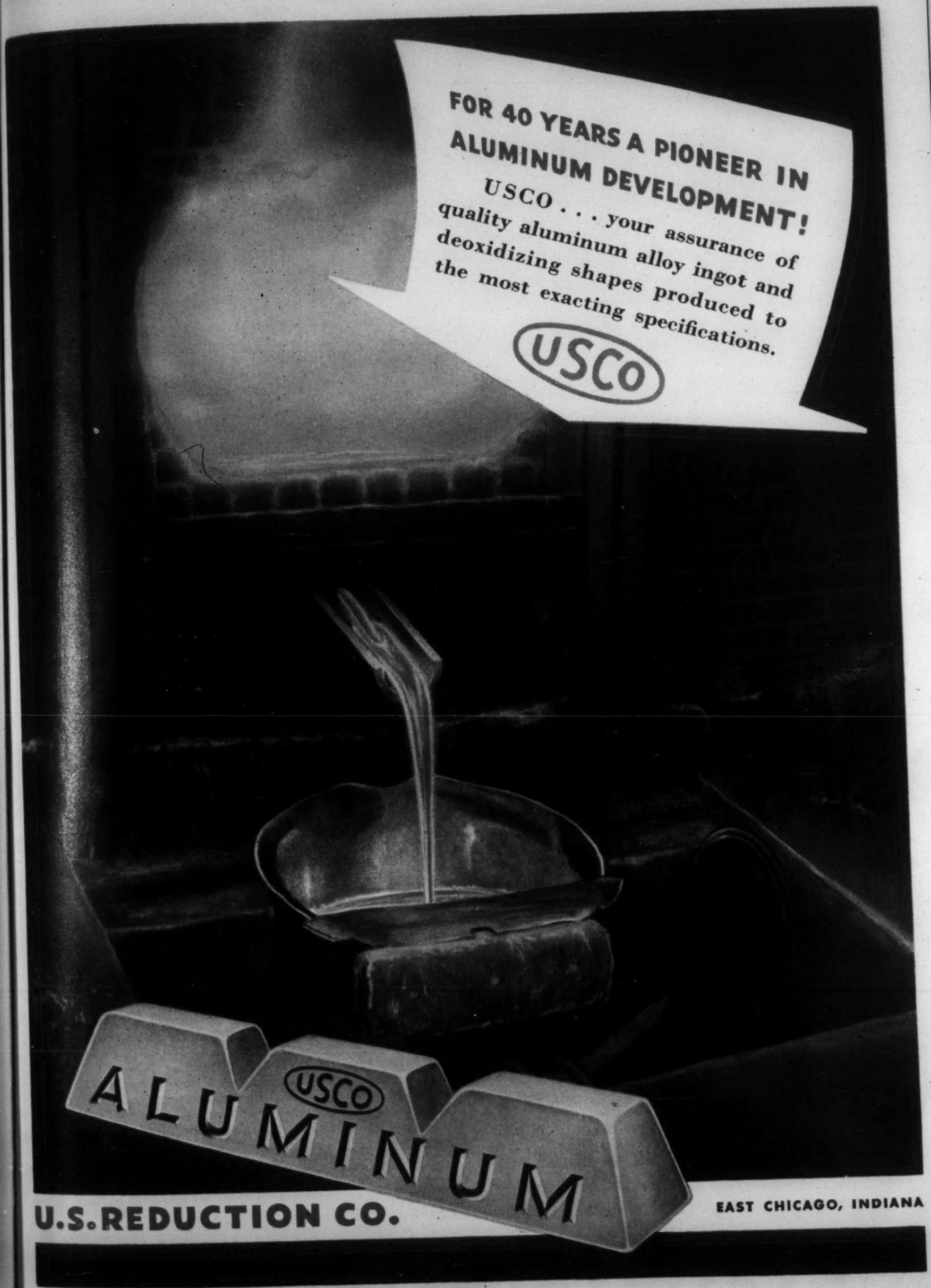
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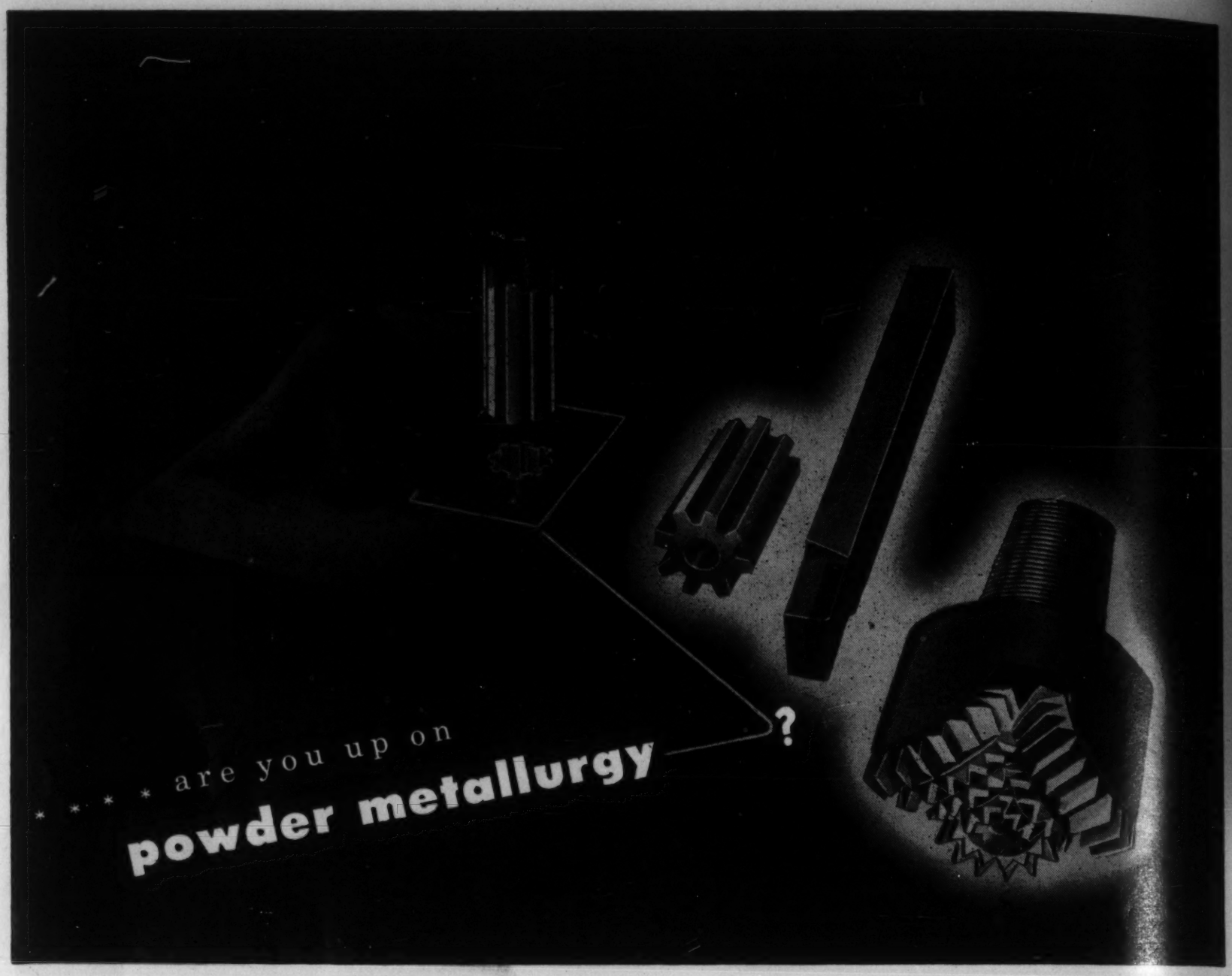

No one at this moment can profess full acquaintance with all the uses of powdered metals. Production is being diversified too rapidly and knowledge of what can be done is being extended too fast, in too many directions, for that. But manufacturers who wish to inform themselves of such developments will find it of interest that the Molybdenum Corporation, being a supplier of high-purity metal powders and alloy powders of exactly specified content, is also a source of advice on many of the new possibilities in this field. Powders of molybdenum, tungsten, and boron, in different particle sizes and different degrees of purity, are made and recommended for different requirements. A descriptive catalog of M.C.A. products is issued and correspondence is invited.

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Offices: Pittsburgh, New York, Chicago, Detroit, Los Angeles, San Francisco, Seattle.
Sales Representatives: Edgar L. Fink, Detroit; H. C. Donaldson & Co., Los Angeles, San Francisco, Seattle.
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MOLYBDENUM CORPORATION OF AMERICA
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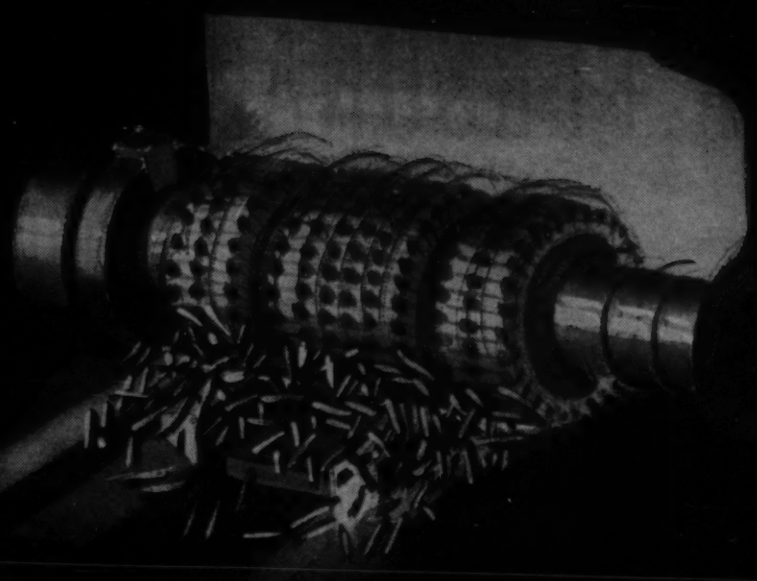
MCA



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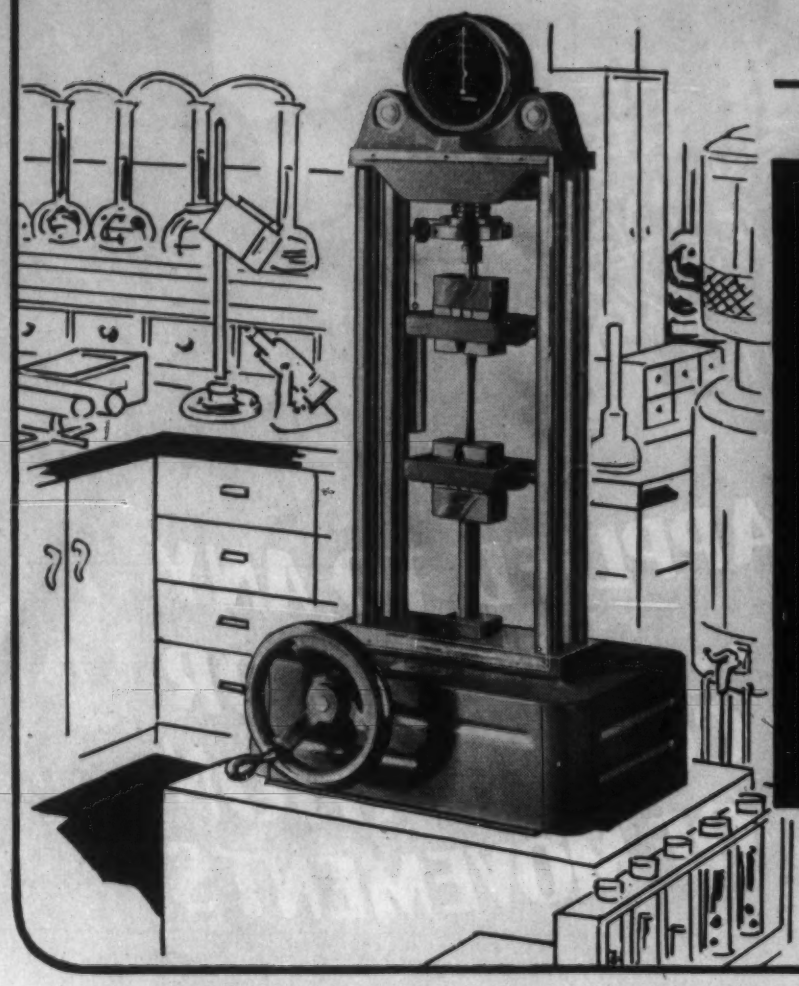

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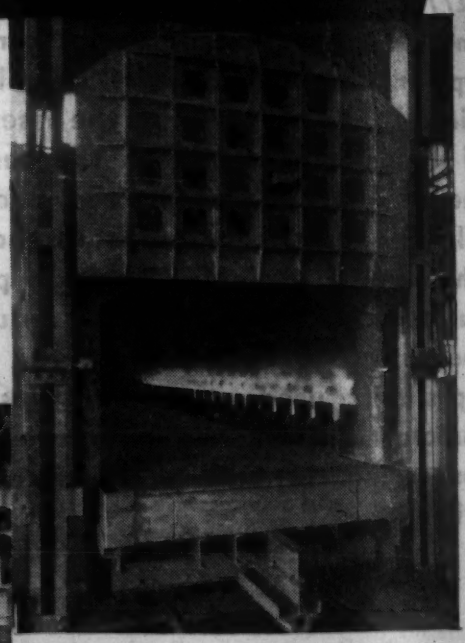
In the production of forgings, rods, bars and rod coils, P.I.E. Car-Type Heat Treating Furnaces prove outstanding in their advantages. They have simple controls and are easy to operate. Because of patented RADI-FLECTO Burners, controlled atmosphere is obtained with faster, more uniform heating and decreased fuel and maintenance costs.

Ask for further information.



Above — Internal view of furnace in battery of P. I. E. Car-Type Heat Treating Furnaces shown at left.

For full information on AMCO Recuperative Pit Furnaces, Open Hearth Furnaces and Large Recuperative Rotating Hearth Furnaces, write to AMSLER-MORTON DIVISION of Union Industries, Inc., Fulton Building, Pittsburgh 22, Pennsylvania.

P-2

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Division of Union Industries, Inc.
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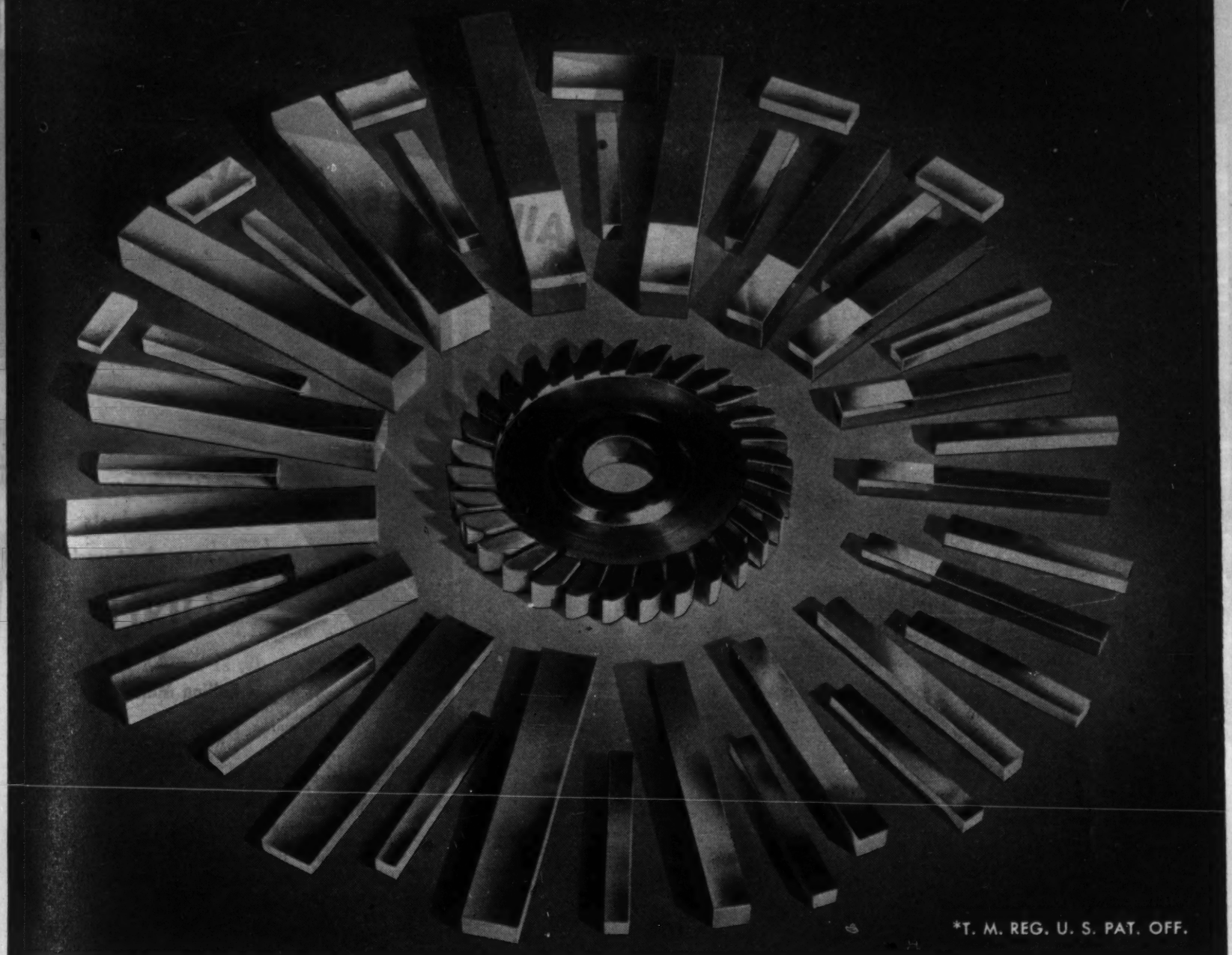

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THE CENTRIFUGALLY CAST BORON COBALT ALLOY

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Extensive research in the field of cutting alloys has resulted in the centrifugally cast ferrous alloy that incorporates the superior Hardness of heat treated steel (Rockwell up to C-71) with the "Red Hardness" of Cobalt, and the "Wear and Abrasion Resistance" of Boron.

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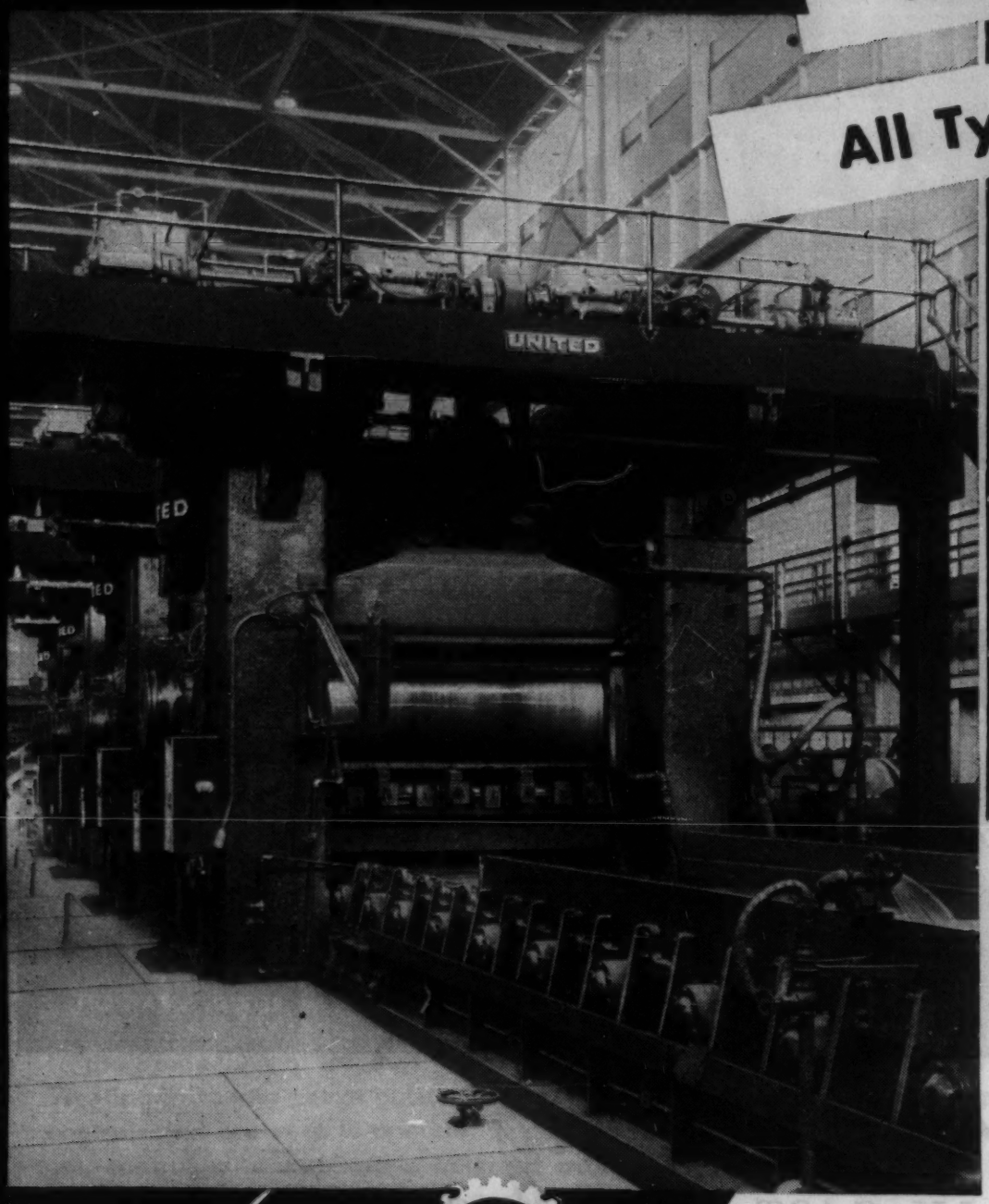

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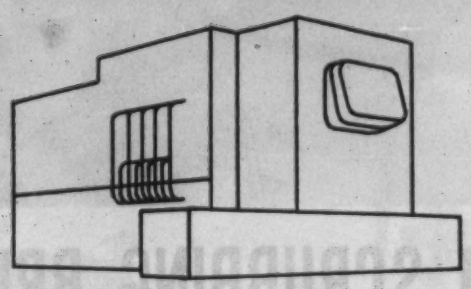
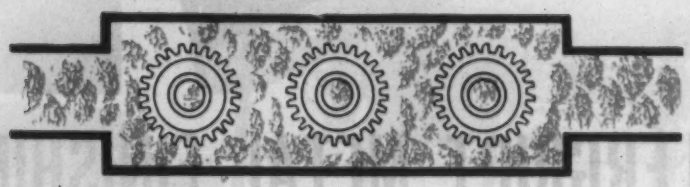
WHERE CONTROL IS NEEDED?

Here is a furnace



Here is where the work is heated



. . . and this is the ONLY PLACE where control REALLY COUNTS!

THE final quality of steel that is being heat treated or carburized is determined in the heating chamber. *That* is where the protection is needed . . . *that* is where the effects of atmosphere CONTROL show its worth.

In Lithium Furnaces the *control* does not stop at some point before the atmosphere enters the furnace . . . it extends into the heating chamber and continues throughout the entire process up to the moment of quenching. The action is wholly automatic. The preferential effect of the Lithium constituent of the atmosphere *is* the CONTROL. Lithium reacts equally with a low-cost combustion gas for neutral heating, and with a carburizing gas for bright eutectoid carburizing, and for the restoration of carbon in decarburized steels Vitally important also, is the prevention of subscale by Lithium, resulting in greatly increased fatigue strength and resistance to wear.

It will pay you to find out how the complexities of atmosphere control are eliminated in LITHIUM ATMOSPHERE FURNACES . . . how neutral heating of steels and bright, eutectoid carburizing become exact, economical processes . . . and how the commercial restoration of carbon in decarburized steel and the prevention of subscale is made possible for the first time in metallurgical history.

LITHIUM *means* **CONTROL AT THE WORK**

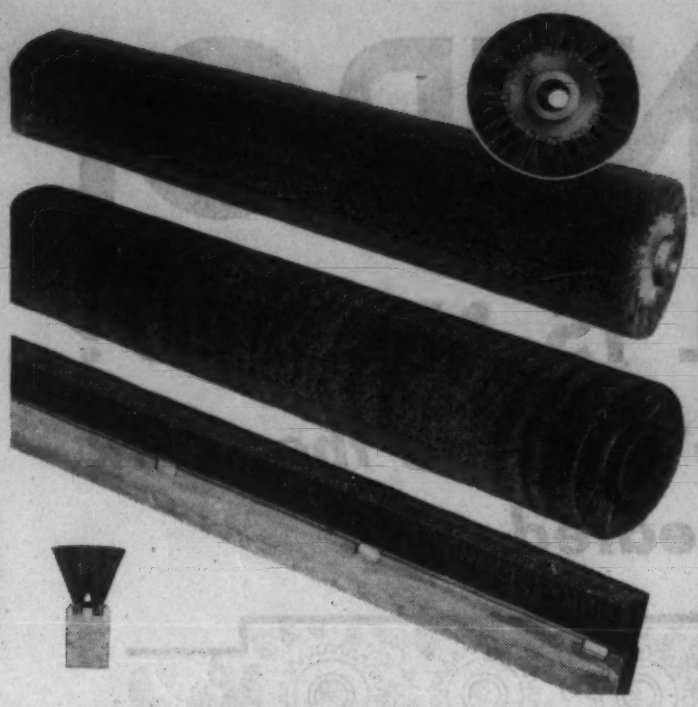
SEND FOR THIS BOOK

It tells how Lithium vapor controls at the work; how it prevents scaling and decarburization; and how it is engineered into atmosphere furnaces for work of superb quality.

THE LITHIUM COMPANY 111 SYLVAN AVE., NEWARK 4, N. J.

Manufacturers of Atmosphere Furnaces for NEUTRAL HEATING . . . BRIGHT EUTECTOID CARBURIZING . . . CARBON RESTORATION . . . PREVENTION OF SUBSCALE . . . LITHIUM FLUID BRAZING . . . CLEANING AND DESCALING

IN CANADA: *The Lithium Furnace Division of Canadian Acme Screw & Gear, Ltd., Toronto*



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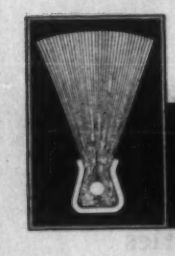
are designed and built for the job to be done. They contain more brush material than other construction—giving a better brushing action and a longer brush life.



Send blue prints and specifications, and place a trial order to be convinced.

THE FULLER BRUSH COMPANY

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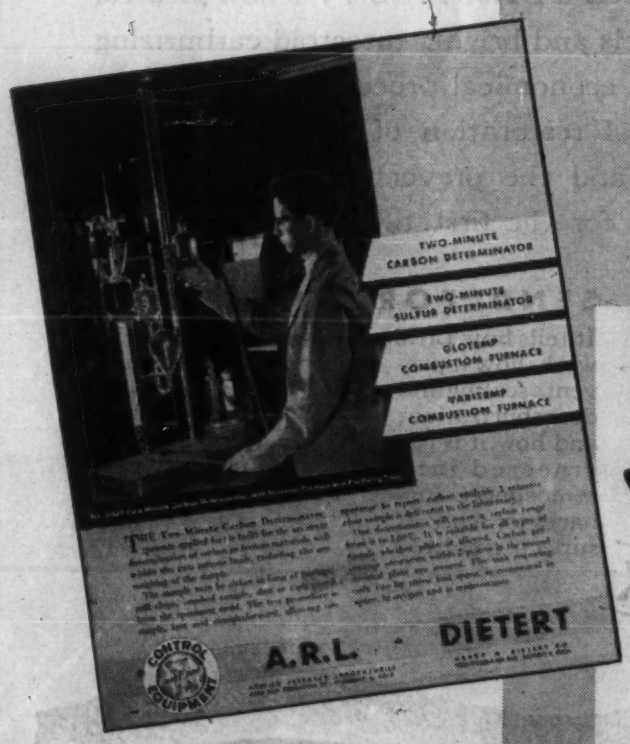

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   Carbon range.....0 to 1.25%, within .005%
3. Speed.....2 minutes for complete determination, plus sample weighing time.
4. Cost of operation, material.....less than 2c per determination
5. Test procedure.....simple, automatic leveling
6. Versatility.....for ferrous and non-ferrous metals
7. Range.....0 to 5.00% carbon

Sulfur Determinator

1. Price.....$146.00
2. Accuracy.....0 to 0.39%, within .002%
3. Speed.....2 minutes for complete determination, plus sample weighing time
4. Cost of operation, material.....approximately 2c per determination
5. Test procedure.....simple, only one solution need be prepared accurately
6. Versatility.....for ferrous and non-ferrous metals
7. Range.....0 to 0.39 sulfur

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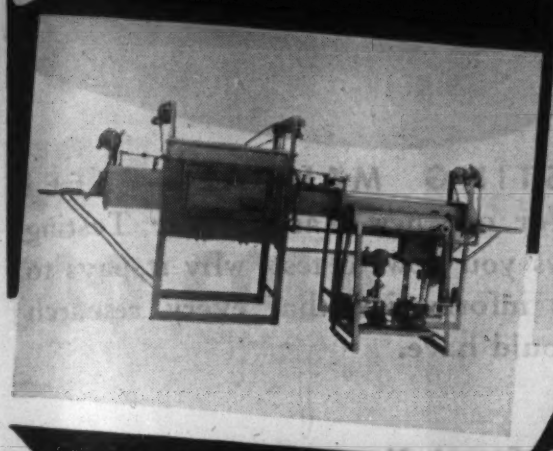
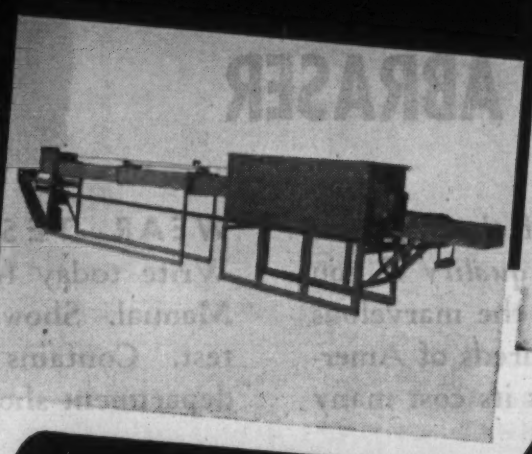
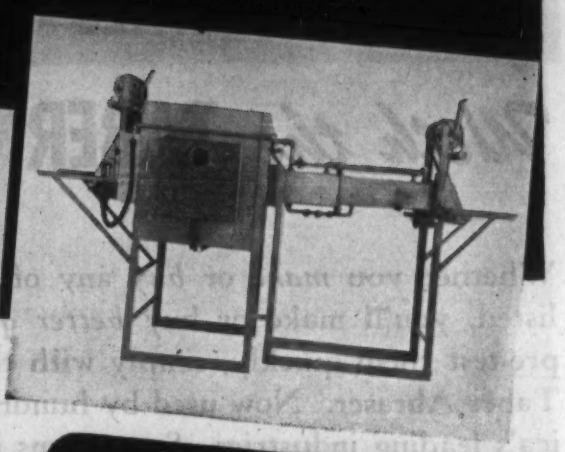
Dependable heat-treating







COPPER BRAZING

ANNEALING

SINTERING

with "Certain Curtain" Atmosphere Control

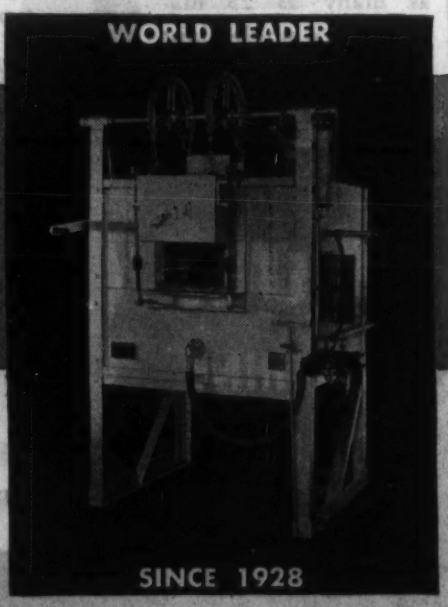
The "Certain Curtain" line has expanded greatly since our original success with the hardening of high speed steel tools, and includes a comprehensive range of heat-treating equipment for practically every application where control of furnace atmosphere is needed. These furnaces are flexible in design, and are adaptable to the type of atmosphere composition best suited to the operation: combusted gas, dissociated ammonia, hydrogen or any desired atmosphere.

The three furnaces shown above are representative types of a variety of models we make for the operations indicated. These furnaces comprise features and numerous refinements of design and construction which enable users to conduct these operations on a highly dependable basis. Temperature ranges are available from 1200° to 2500° F. Made in conveyor and batch types.

REQUEST BULLETINS

"Certain Curtain"

CONTROLLED-ATMOSPHERE FURNACES



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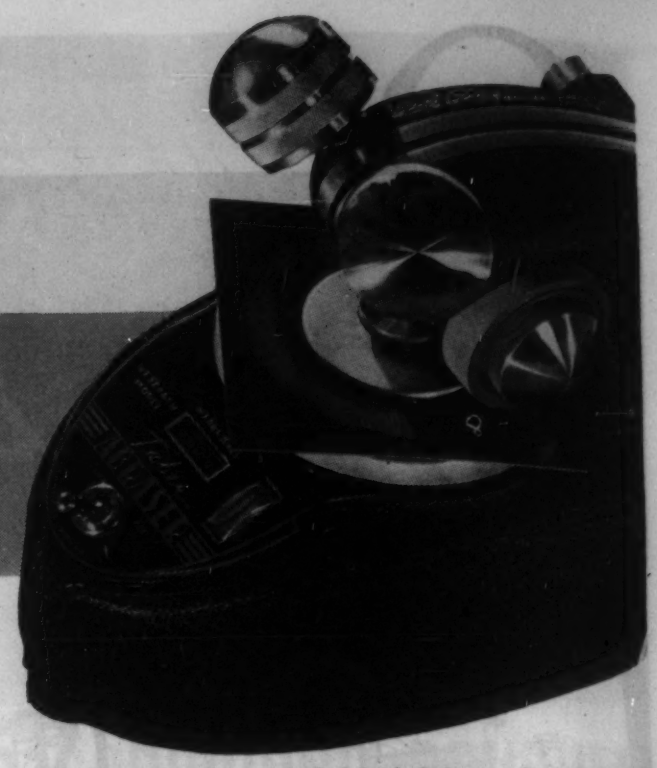

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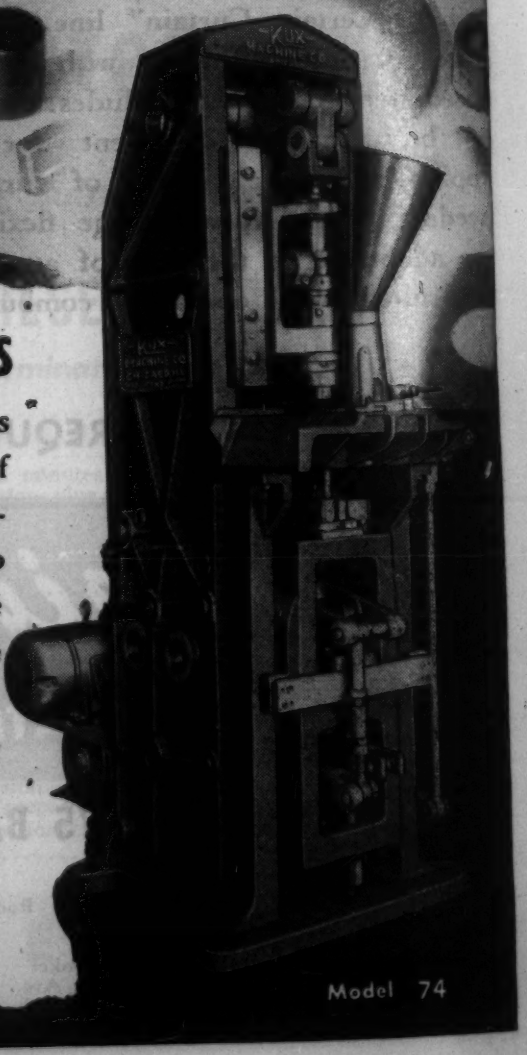

Model 74

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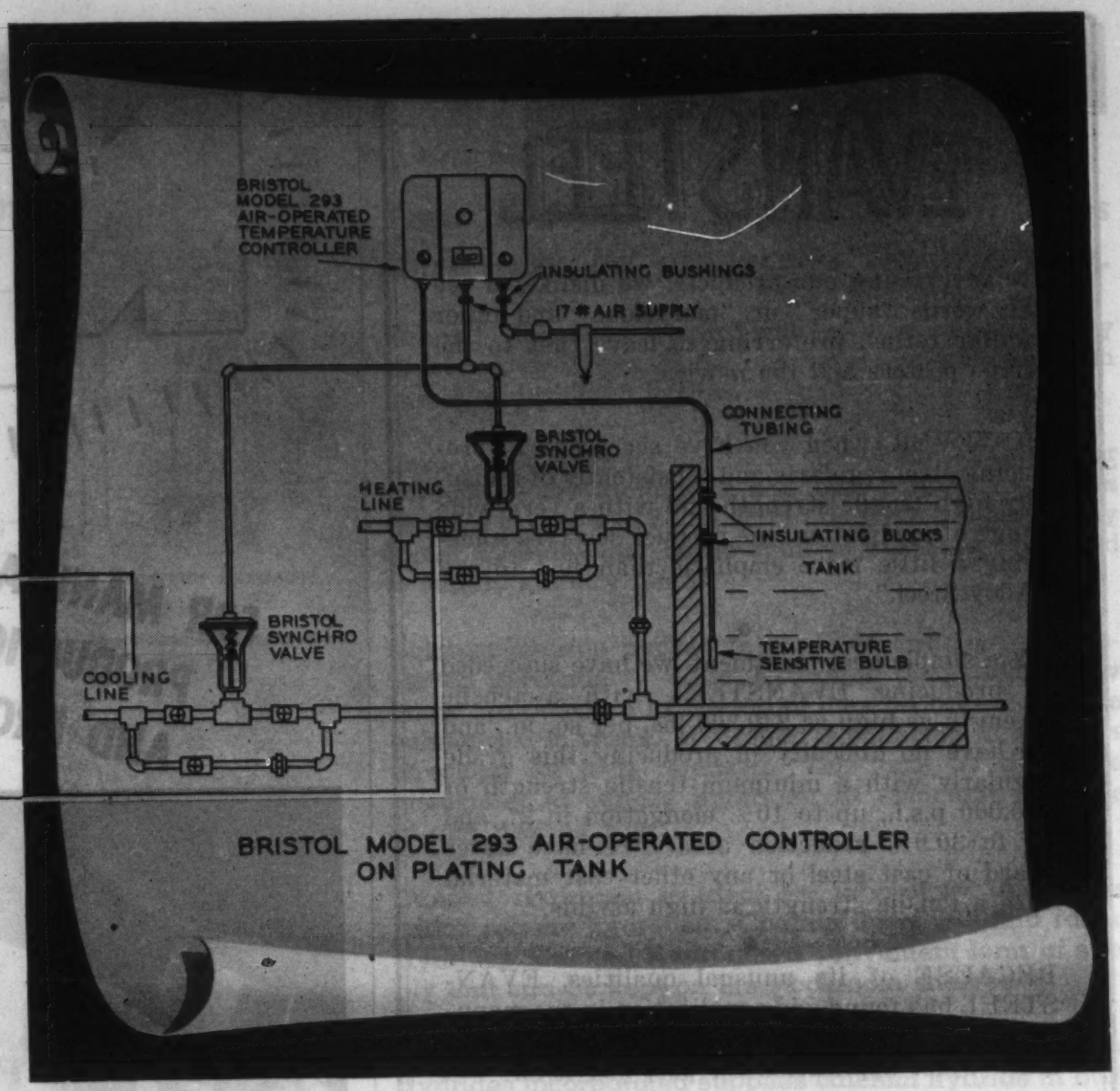


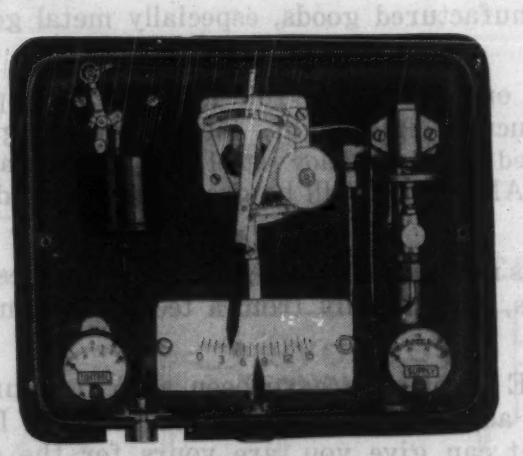
BRISTOL MODEL 293 AIR-OPERATED CONTROLLER ON PLATING TANK

How to improve quality of plating by keeping the bath at the right temperature

Bristol's new Model 93 Air-Operated Controller puts temperatures under accurate and continuously uniform control with accurate readings continuously indicated.

It is the ideal instrument for controlling temperatures of all types of plating, cleaning and pickling tanks, where chart records are not needed.

A new bulletin, No. A115, gives complete details. Write for a free copy to THE BRISTOL COMPANY, 162 Bristol Road, Waterbury 91, Conn. (The Bristol Co. of Canada, Ltd., Toronto, Ontario. Bristol's Instrument Co., Ltd., London, N.W. 10, England.)



Bristol's Model 93 Air-Operated Indicating Controller. Other Bristol instruments for these applications include recording air-operated controllers, electrically-operated (mercury contact) indicating or recording controllers, and open-contact indicating controllers. These Bristol instruments are described in Data Sheet No. 45.

BRISTOL ... *Gives YOU the Most from Heat*

AUTOMATIC CONTROLLING AND RECORDING INSTRUMENTS

EVANSTEEL

IN advertising our products, we dislike to use the words "super" or "marvelous" and other similar terms, preferring to leave that to the circus posters and the movies.

•

HOWEVER, when you have succeeded in producing steel regularly and consistently of unusually high tensile strength and with a very wide range of application, the product deserves something a little more emphatic than just to say "Alloy Steel."

•

BY a simple heat treatment, we have succeeded in producing EVANSTEEL with a tensile strength as high as 249,300 lbs. per sq. in., and we have no difficulty in producing this grade regularly with a minimum tensile strength of 180,000 p.s.i., up to 10% elongation in 2", and up to 30.9% reduction area. We have never heard of cast steel or any other cast material with a tensile strength as high as this.

•

BECAUSE of its unusual qualities, EVANSTEEL has found wide application in the manufacture of war equipment and will, no doubt, find much wider application for post-war uses.

•

UNDOUBTEDLY, as a result of the war, there will be vast improvements in the quality of manufactured goods, especially metal goods.

•

IN order to take full advantage of possible reduction in weight, increased strength and added service, alloy steel of the character of EVANSTEEL will be greatly in demand.

•

IT is not too early to begin discussing these problems, even if only from a technical standpoint.

•

THE results we have been able to secure, and any assistance which our Engineering Department can give you, are yours for the asking, without cost or obligation.

Write for our Bulletin on EVANSTEEL

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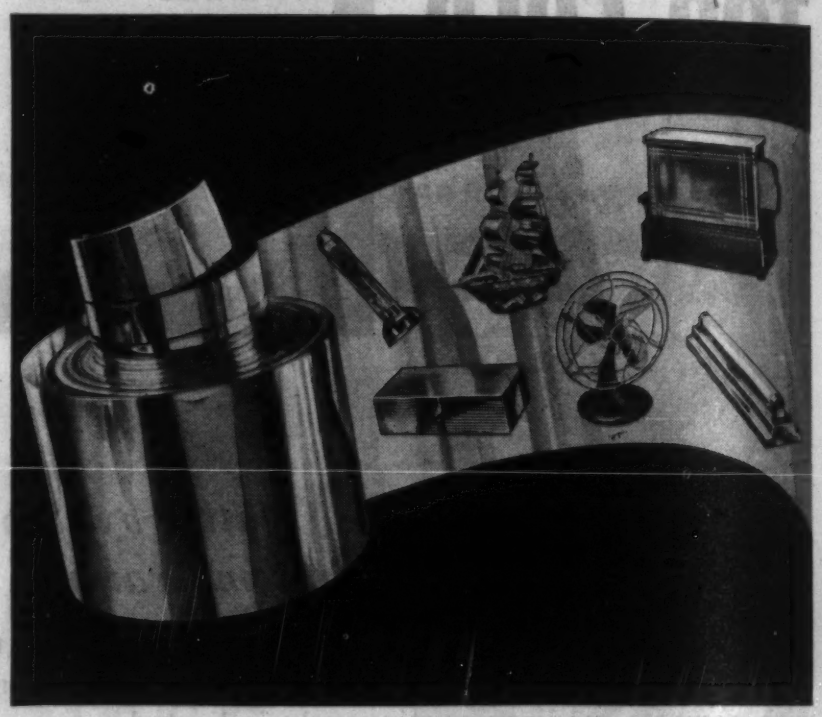

• Lessons learned in wartime manufacturing have made it easier for us to tell you about Nickeloid Metals. *One wartime lesson* was that costly basic metals could be eliminated and less expensive ones used if the surface were electroplated with a durable, corrosion-resistant coating such as chromium, nickel, copper or brass. *Another wartime lesson* that proved our case was simplification of manufacturing procedure . . . eliminating operations, and thus reducing costs while speeding production. Nickeloid Metals are tailor-made for high-speed, automatic fabrication. Production experts recommend them. Write us for more information.

NICKELOID Pre-Plated METALS

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Electro-plated TO ALL COMMON *Base* METALS

ALSO LACQUERED COLORS SHEETS AND COILS

OLDEST AND LARGEST PRODUCERS OF PRE-PLATED METALS

AMERICAN NICKELOID COMPANY

Established 1898

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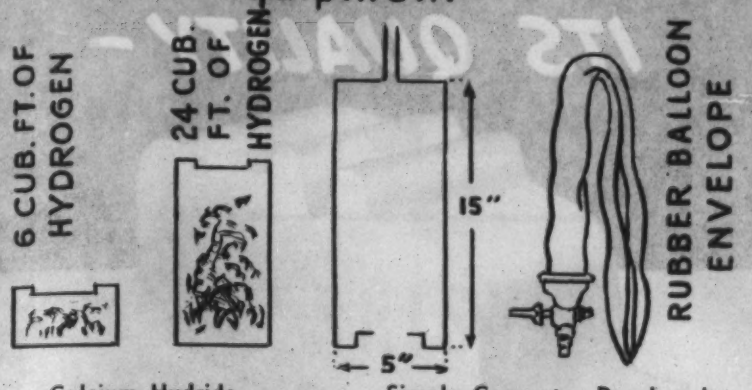
CANNED HYDROGEN

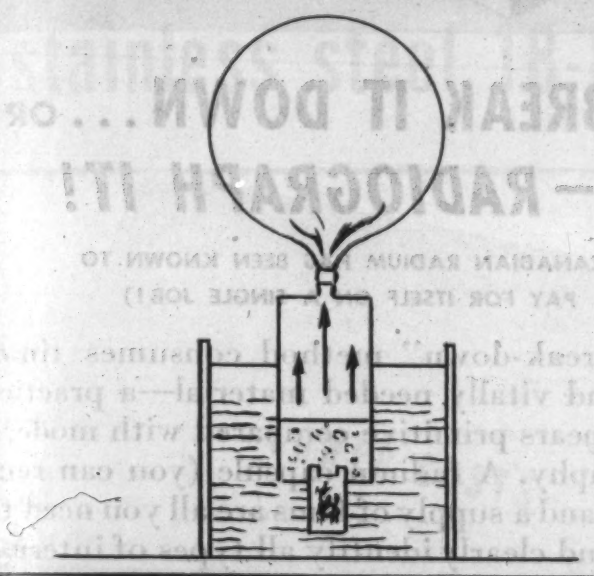
1. Equipment



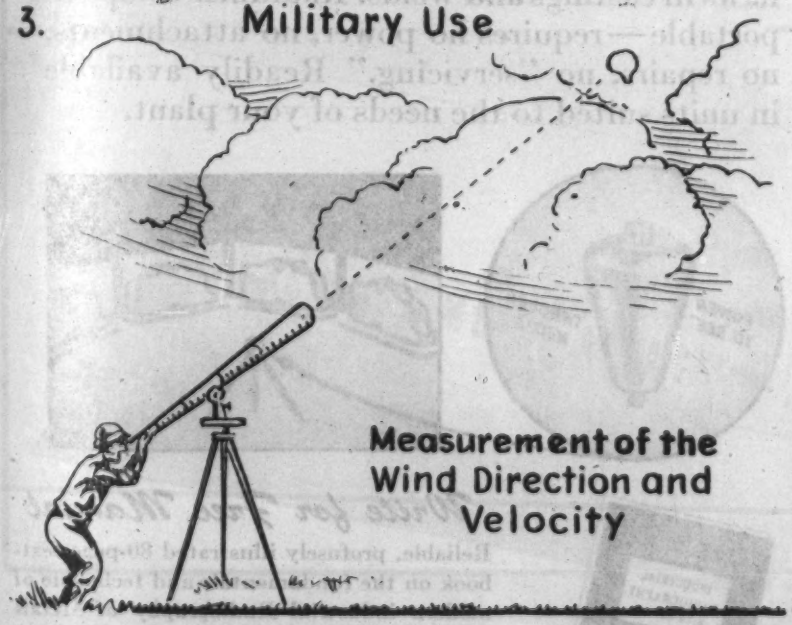
Calcium Hydride Charges

Simple Generator Developed by Sig. Corps

2. Inflation of the Balloon



3. Military Use



Measurement of the Wind Direction and Velocity

Your hydrogen supply in small cans that may be preserved indefinitely.

Canned Hydrogen began with a war, when heavy hydrogen cylinders could not be transported through jungle and difficult terrain.

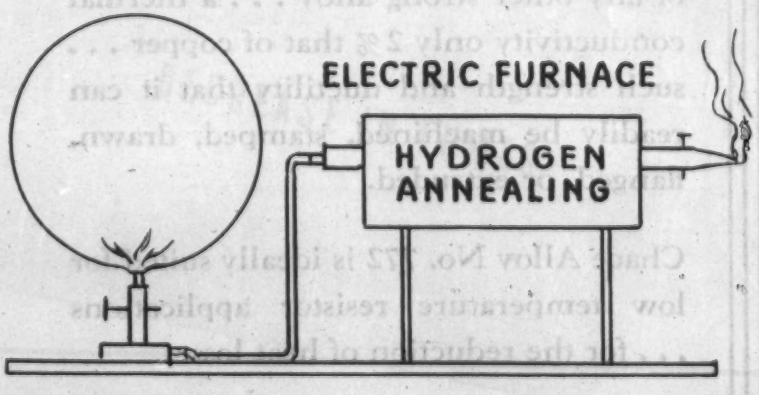
Used in the field by the U. S. Army Signal Corps for inflation of meteorological balloons, canned hydrogen charges giving 6 to 24 cu. ft. of gas were developed by Metal Hydrides Inc. Large tonnage has been produced to supply military needs.

Calcium hydride packed in small tin cans can be preserved indefinitely. When hydrogen is needed, a few holes are punched in the top of the can and the whole submerged in water. Hydrogen is collected in a rubber envelope as it is released. This acts as a simple gasometer to supply hydrogen at sufficient pressure at any desired rate.

Canned Hydrogen is ideal for laboratory operations which require hydrogen. Civilian users will find Metal Hydrides' Canned Hydrogen a convenient form of supply that can be kept on the stockroom shelves.

For production of hydrogen on a large scale, Metal Hydrides Incorporated supplies calcium hydride in bulk for use in acetylene generators. In such a case, instead of calcium carbide, crushed calcium hydride is fed to produce hydrogen.

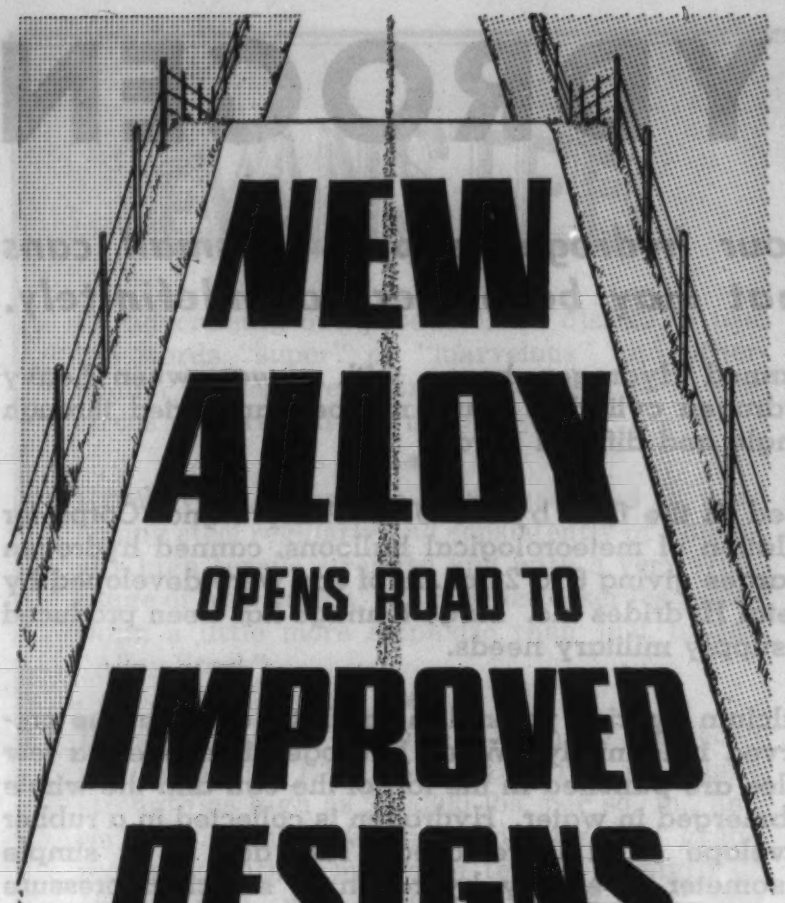
4. Civilian Use



METAL HYDRIDES INC.

FACTORY AND SALES OFFICE

12-24 Congress Street — **Beverly, Massachusetts**



NEW ALLOY OPENS ROAD TO IMPROVED DESIGNS

Chace Manganese Alloy No. 772 affords a unique combination of engineering properties that opens the way to many better-designed post-war products.

Briefly, those properties are: an electrical resistivity 60% higher than most commonly used alloys . . . a temperature coefficient of expansion higher than that of any other strong alloy . . . a thermal conductivity only 2% that of copper . . . such strength and ductility that it can readily be machined, stamped, drawn, flanged, or extruded.

Chace Alloy No. 772 is ideally suited for low temperature resistor applications . . . for the reduction of heat losses.

Chace Alloy No. 772 is being produced in sheets, strips and rods. Bulletin No. A-942—detailing physical properties and suggesting applications—is yours for the asking.

W.M. CHACE CO.

Manufacturers of

Thermostatic Bimetals and Special Alloys

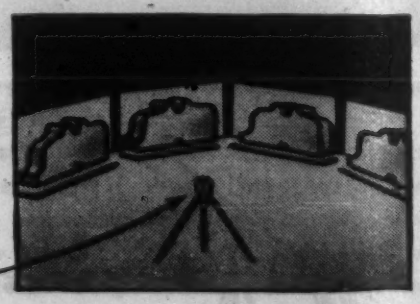
1615 BEARD AVE • DETROIT 9, MICH.

CANADIAN RADIUM IN MODERN INDUSTRY

1—BREAK IT DOWN... OR 2—*RADIOGRAPH IT!*

(CANADIAN RADIUM HAS BEEN KNOWN TO PAY FOR ITSELF ON A SINGLE JOB!)

The "break-down" method consumes time, labor and vitally needed material—a practice that appears primitive compared with modern radiography. A radium capsule (you can rent or buy) and a supply of films are all you need to locate and clearly identify all types of internal flaws in castings and welds. Radium is compact, portable—requires no power, no attachments, no repairs, no "servicing." Readily available in units suited to the needs of your plant.



R-144

Write for Free Manual

Reliable, profusely illustrated 80-page textbook on the fundamentals and technique of modern industrial Radiography of Metals with Radium. Specially prepared for the metals industry by our research and technical staff. Write for your copy today, giving your name and company position.

CANADIAN RADIUM & URANIUM CORPORATION

630 FIFTH AVE., ROCKEFELLER CENTER, NEW YORK 20, N.Y.

5 REASONS

why FERRISUL is preferred for pickling stainless steel 18-8

SMOOTHER SURFACE

FASTER PROCESS

LOWER COSTS

DECREASE IN FUMES

LESS BASE METAL ATTACK

Today, with most pickle houses working at peak capacity, Ferrisul's ability to *speed up* and thereby *increase* production, has made it doubly welcome on that count alone.

For example, by including Ferrisul (anhydrous ferric sulfate) in the sulfuric acid prepickle, the time in the prepickle has been *reduced by 50-75%* and the time in the straight pickle, whether Ferrisul-hydrofluoric acid, or nitric-hydrofluoric, has been reduced *approximately 50%*.

In addition, stainless steel manufacturers have been quick to appreciate other Ferrisul advantages: (1) the controlled pickle achieved with Ferrisul provides smoother, brighter surfaces with practically no metal loss or chemical waste; (2) the combination of Ferrisul with hydrofluoric acid gives an efficient one-bath pickle; (3) Ferrisul greatly reduces the health and safety hazard of fumes; (4) Ferrisul in granular form is easy and safe to handle and store.

For complete information on Ferrisul and a new bulletin on the use of Ferrisul in pickling stainless steels, write: MONSANTO CHEMICAL COMPANY, Merrimac Division, Everett Station, Boston 49, Massachusetts.

MONSANTO CHEMICALS

SERVING INDUSTRY...WHICH SERVES MANKIND

PRECISE TEMPERATURE CONTROL of Mills Thermo-plastics

insured with

WHEELCO Capacitrols

Elmer E. Mills Corporation, Chicago, chose Wheelco Proportioning Type Capacitrols for fast and accurate temperature control of two zones of a plastics extrusion machine producing tubing and other products for process use. Wheelco Capacitrols are also used on injection molding equipment.

These "Electronic Control Principle" controllers insure closer control than is usually available, by the reduction of over and undershooting of temperatures.

Extrusion machines at Mills produce vinylidine chloride (MILLS PLASTIC) products used extensively in process and food industries. MILLS PLASTIC tubing has replaced aluminum, copper, brass, nickel and stainless steel on many applications because of its ability to stand high pressures, its insulating qualities, resistance to chemicals and flexibility.

Let us help you on your temperature control problems.

WHEELCO CONTROLS

A complete line, including Flame-otrol combustion safeguards . . . Capacitrol pyrometer controllers . . . Indicating pyrometers . . . Proportioning controls . . . Program controls . . . and a wide range of accessories.

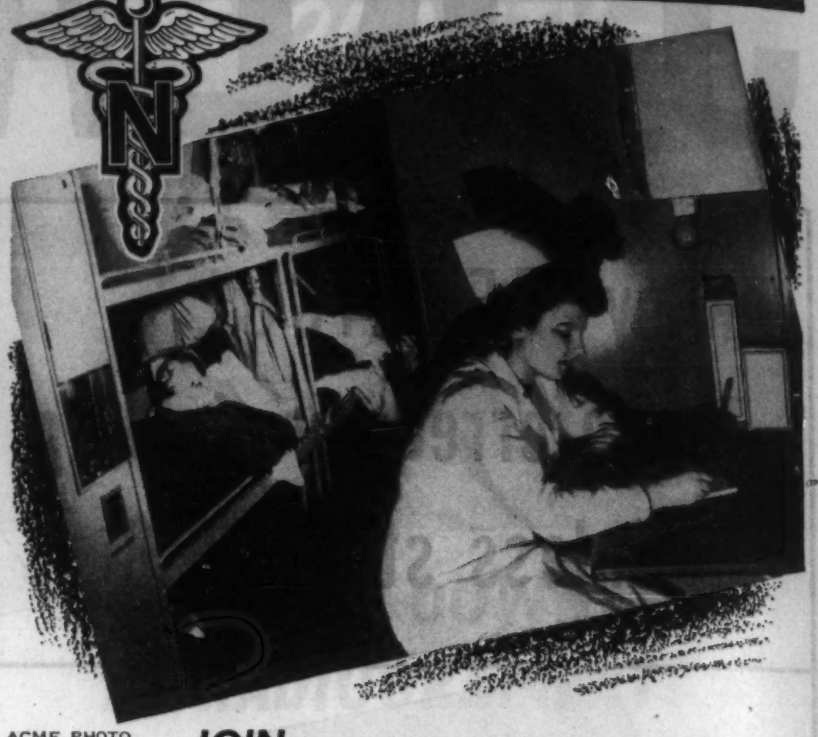
Ask for Condensed Catalog Z6300

WHEELCO INSTRUMENTS COMPANY

861 W. Harrison St. Chicago 7, Ill.

WHEELCO

You are needed Now More than Ever!



ACME PHOTO

JOIN the Army of splendid nurses that are rendering superb service in the care of our wounded soldiers coming back from victorious battlefields.

"OH 38"

"OH 38" is needed now, too, for the vitally essential parts we are making for Army and Navy weapons and equipment. It's the Aluminum Alloy that surpasses all others for a wide variety of uses. Easily machinable—holds threads without stripping—weighs .106 lb. per cubic inch—tensile strength 35,000 to 40,000 lbs. per sq. in.—non-corrosive, non-oxidizing, non-magnetic—needs no heat treatment—polishes to mirror brilliancy—takes chrome, nickel or tin plating—may be annodized—many other advantages. Used exclusively in castings by Hedstrom.

SEND FOR COMPLETE TECHNICAL INFORMATION

HEDSTROM

OSCAR W. HEDSTROM CORP.

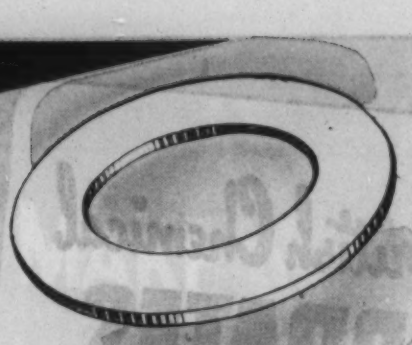
4822 West Division St., Phone Columbus 3667, Chicago, 51, Ill.

Manufacturers of Aluminum, Brass, Bronze and High Conductivity Copper Castings. Pattern Makers. Complete Mechanical Assemblies and Models to Specifications

How to Produce Medium-Deep Cases Economically

Two Examples of Short-time Case Hardening at Direct Quenching Temperatures with Du Pont ACCELERATED SALT

1.



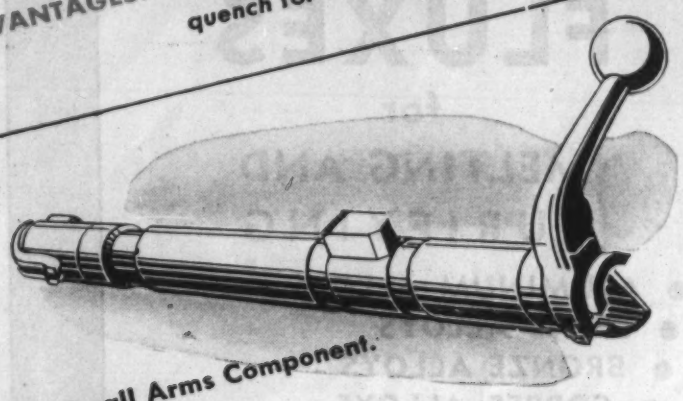
Description: Thrust Washer.
Steel: SAE 1020.

Specifications:
Case depth—0.030 to 0.035″ total.
Hardness—Rockwell C 60 to 62, file-hard.

Treatment: 1600° F. for 3 hrs. in Du Pont Accelerated Salt Bath, followed with direct oil quench.

ADVANTAGES: Sufficient nitrogen in the case to harden with oil quench for minimum distortion.

2.



Description: Small Arms Component.
Steel: NE 8620.

Specifications:
Case depth—0.012 to 0.015″, measured on polished and etched section.
Hardness—Rockwell D 62 to 70, after drawing.

Treatment: 1600° F. for one hour in Du Pont Accelerated Salt Bath, followed with direct oil quench.

ADVANTAGES: Close tolerance in depth of case is consistently met.

HERE is an ideal all-purpose salt for cases from 0.010–0.035″ at temperatures from 1500° F. to 1650° F.

It produces carbon-nitrogen cases similar to those obtained in plain cyanide baths.

It provides full hardness on relatively light sections of plain carbon steels, which must be oil quenched to minimize distortion.

It can be used for reheating medium- to high-carbon alloy and carbon steels, including National Emergency substitute steels.

Copper localized work is hardened without case penetration through the copper plate.

No matter what your case hardening needs may be, there are Du Pont heat-treating products that will combine top production and maximum economy for you. Du Pont technical men are glad to work with you in selecting the best materials for your specific operation. Write: E. I. du Pont de Nemours & Co. (Inc.), Electrochemicals Dept., Wilmington 98, Delaware.

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. . . THROUGH CHEMISTRY

WRITE TODAY—USE V-MAIL!

DU PONT
CYANIDES AND SALTS
for Steel Treating

American British Chemical
FOUNDRATES
REG. TRADE MARK

Scientifically Blended
FLUXES
for
MELTING AND
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- ALUMINUM ALLOYS
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MICAWASH—
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The Improved Original Mica Foundry Products

- Core and Mold Washes
- Coatings for Permanent Molds, Pots, Kettles, Etc.
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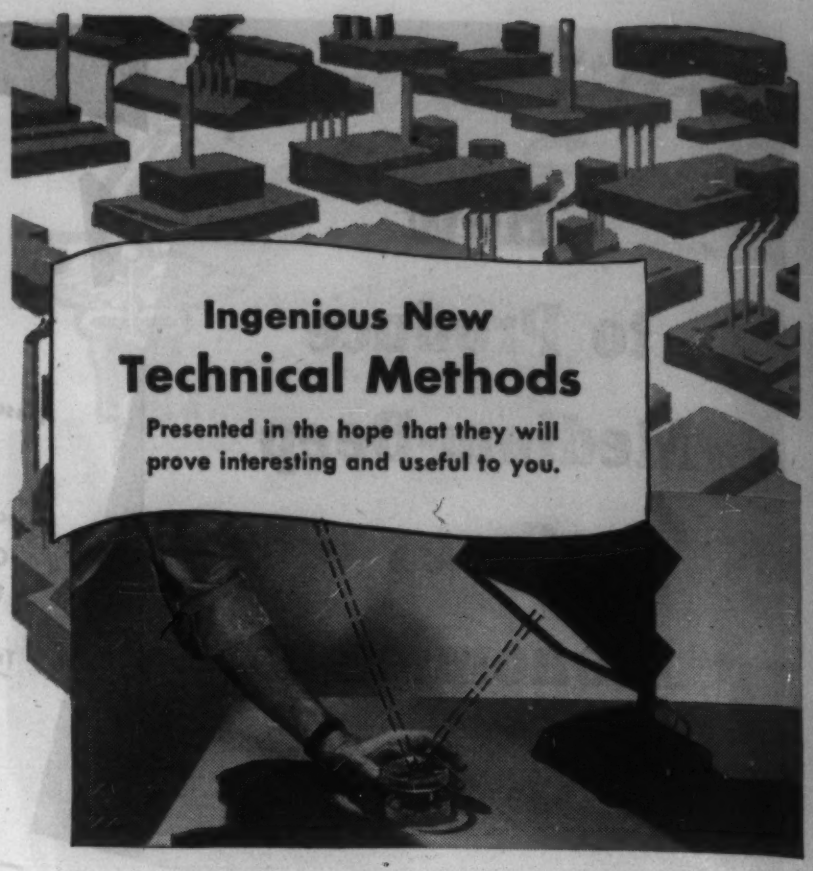
American-British Chemical Supplies, Inc.
180 Madison Avenue, New York 16, N.Y.
Telephone: AShland 4-2265



Now! Shop Measurements to *One Millionth of an Inch*

With Simple Light Wave Setup!

The wave length of light is the basis for this amazing new optical measuring equipment—which measures millionths of an inch as easily as a micrometer measures tenths! All that is required, in addition to a simple setup, is average eyesight, intelligence and arithmetic.

The Monochromatic Light.

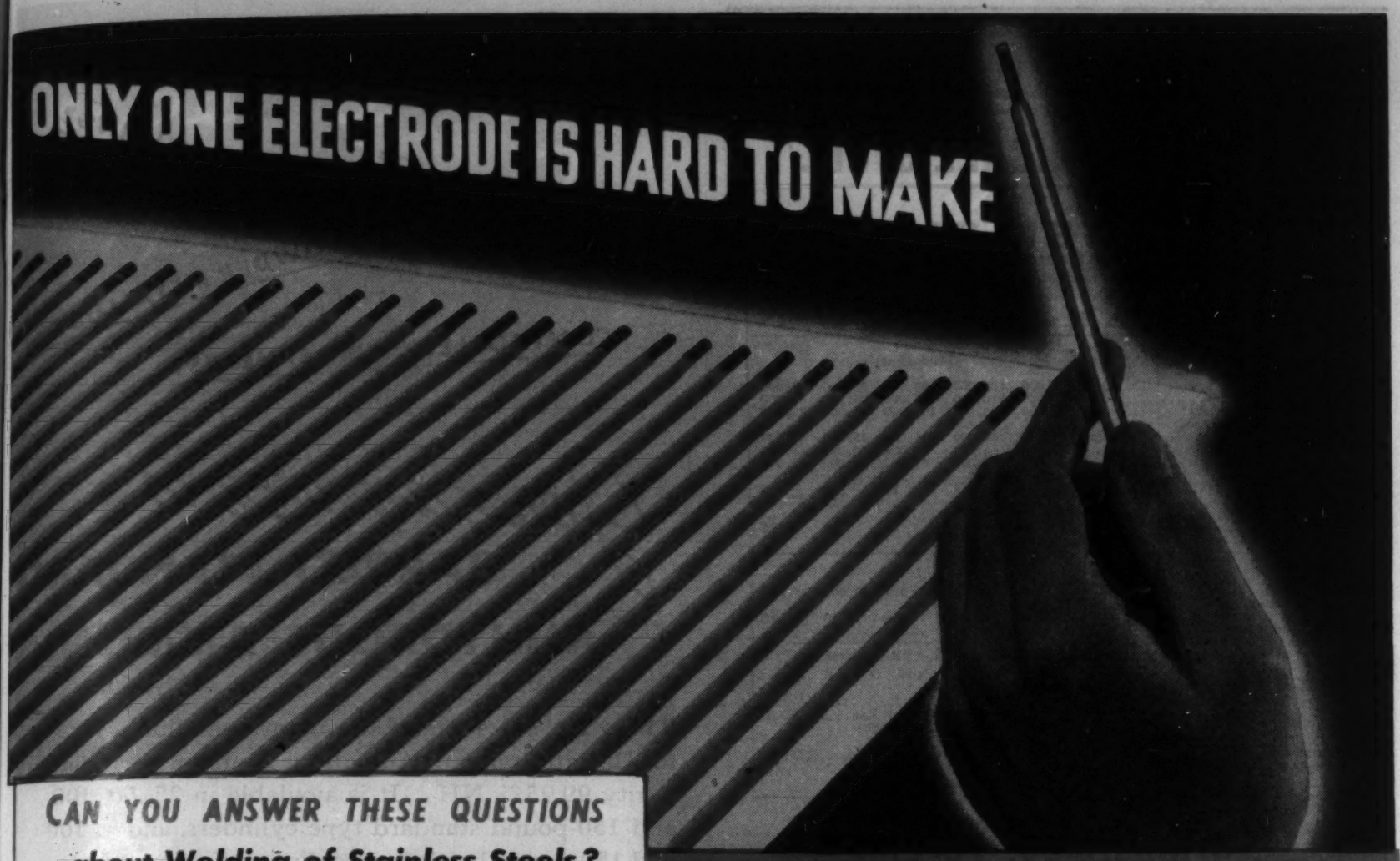
As shown above, the work was placed under the Monochromatic Light, upon the work and gauge block—and covered by the optical flat. The light, reflected back to the operator, by the top and bottom surfaces of the optical flat, creates interference bands, representing height intervals of 11.6 millionths of an inch. So that from the center of one dark band to the center of the next, the level of the work has risen or fallen 11.6 millionths of an inch. The bands, simply, are a contour map of the surface. This fact, in a simple mathematical formula, is sufficient to explain all the shop uses of optical flats, and give the work measurement, quickly and accurately.

Optical Flat. Surface of Work. Interpretation of bands on truly flat surfaces.

No longer, however, can your dealer give you Wrigley's Spearmint Gum. Today, under present conditions, this product cannot be manufactured up to Wrigley's quality standards. To protect consumer and dealer alike, the makers of Wrigley's Spearmint have decided to keep the quality Wrigley's Spearmint wrapper empty. Remember this wrapper, it means chewing gum of finest quality and flavor.

You can get complete information from Acme Scientific Division of Acme Industrial Co., 200 No. Laflin Street, Chicago 7, Illinois

Z-7



that's the FIRST ONE

The first electrode of a new type, or a definite improvement of an old one, is always hard to make.

Once the perfection of the "sample" is established, the ability to turn out millions of duplicates belies the difficulties overcome in the creation of that *first* satisfactory new one. Months, sometimes years, of research and experiment are necessary in our own laboratories and through our Fellowship at the Mellon Institute, to achieve the exact combination of physical properties, operating characteristics and standards of performance required of each new McKAY Electrode.

Thereafter, all others of the adopted type, are copies of the original.

That these "copies" may be faithful reproductions, McKAY assures uniform production by careful analyses of core wire and coating ingredients, constant supervision, frequent checks of production samples and rigid inspection.

So, from *first* to *last* . . . from research through production . . . McKAY mild, alloy and stainless steel electrodes are made to be better. Try them and see.

CAN YOU ANSWER THESE QUESTIONS *about Welding of Stainless Steels?*

	TRUE	FALSE
11. Molybdenum is added to stainless steels to increase their scaling resistance at elevated temperatures.	☐	☐
12. Not all stainless steels are classified by metallurgists as "austenitic."	☐	☐
13. Stainless steel electrodes are used on reverse polarity because they will not operate satisfactorily on straight polarity.	☐	☐

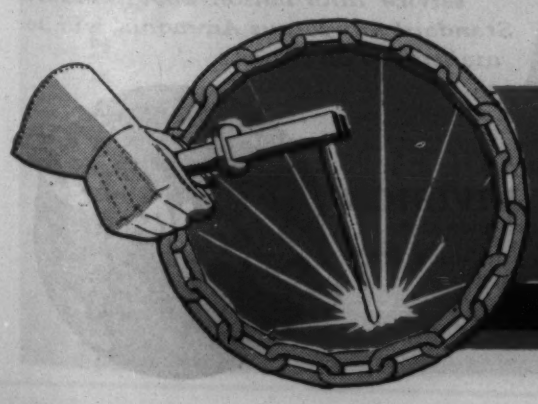
Answers: 11. False; 12. True; 13. True.

Questions 1 to 10, inclusive, have appeared in preceding advertisements. Other questions will appear next month. Watch for them!

Send for this Booklet

A limited number of these valuable booklets are still available for distribution. We shall be glad to send you a copy upon request. Ask for "Things to Know about Welding Stainless Steel."

GENERAL SALES OFFICES: YORK, PA.



THE McKAY COMPANY
PITTSBURGH, PA.

WELDING ELECTRODES . . . COMMERCIAL CHAINS . . . TIRE CHAINS

Here's a Bronze

"as strong as NICKEL STEEL"

HY-TEN-SL
A Bronze as Strong as Nickel Steel
TRADE-MARK

Grade of HY-TEN-SL	1AA	1A	1	2	3	4
TENSION						
Ultimate tensile strength lbs. per sq. in.		(Minimums)				
Sand Cast	125,000	115,000	108,000	100,000	90,000	85,000
Rolled 1" and under	.....	120,000	110,000	105,000	95,000	85,000
Rolled or Forged, over 1"	.....	115,000	108,000	100,000	90,000	85,000
Yield Point (divider method)						
Sand Cast	95,000	75,000	60,000	55,000	45,000	40,000
Rolled 1" and under	.....	75,000	65,000	60,000	50,000	45,000
Rolled or Forged, over 1"	.....	75,000	65,000	60,000	50,000	45,000
Elongation in 2"—%						
Sand Cast	10	12	14	15	20	25
Forged or Rolled	.....	12	13		15	20
Reduction in area—%						
Sand Cast	.....	12	14	15	20	25
Forged or Rolled	.....	12	13		15	20
COMPRESSION						
Yield Point—lbs. per sq. in.	70,000	65,000	58,000	50,000	40,000	35,000
Permanent Set at 100,000 lbs. per sq. in. (max.)	.015	.020	.030	.050	.080	.125
Brinell hardness, No.	250	240	220	200	175	150

List of U. S. Government Specifications Covering HY-TEN-SL Bronze

ARMY
Forgings, Rolled Rod QQ-B-721 Class B
Castings...QQ-B-726 Class B and C

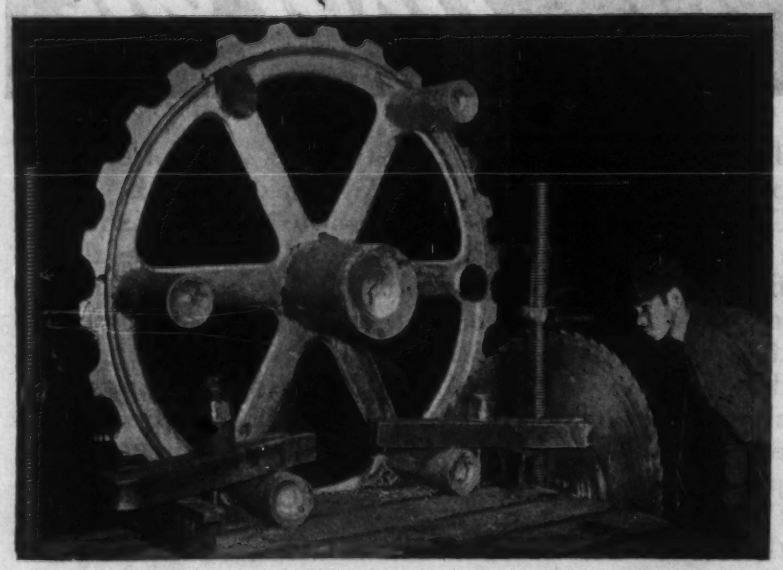
NAVY
Forgings and Rolled Rod 46B15d Class B
Castings, Aluminum-manganese Bronze 46B29

WATERTOWN and OTHER ARMY ARSENALS
Castings WXS-5
Forgings and Rolled Rod.....WXS-2

NAVAL GUN FACTORY
Washington Navy Yard
Castings—Trunnion Metal.....O.S.550

AIRCRAFT
See Navy and Army (above).

. . . in Castings; Forgings; Hot-Rolled Rods and Bars



Manganese Bronze Sprocket for Ammunition Conveyor, 52" dia., 475 lb. each.

Hy-ten-sl is an aluminum manganese bronze,—and being the *strongest and toughest Bronze known,* it has for years been used for the most severe and exacting service. It is shock and fatigue resisting, pressure tight, erosion resisting and corrosion resisting to the elements and certain acids;—further, it is non-magnetic, light in weight, and wear resisting under heavy, slow-moving loads.

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NEW YORK CITY • PITTSBURGH, PA.
35 YEARS' EXPERIENCE

NITRIDING STEELS?
BRIGHT ANNEALING?
ATOMIC WELDING?
POWDER METALLURGY?
CONTROLLED ATMOSPHERES?

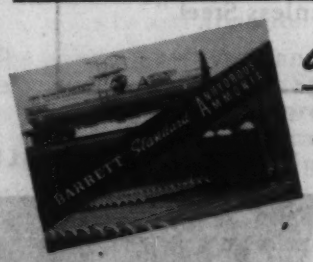
Your answer is

BARRETT STANDARD ANHYDROUS AMMONIA

These are but some of the many metallurgical uses for Barrett Standard Anhydrous Ammonia—minimum purity 99.95% NH_3. It is available in 25, 50, 100, and 150-pound standard type cylinders, and in 100 and 150-pound bottle-type cylinders, for immediate shipment from conveniently located warehouses. Also in tank cars, with a capacity of 26 tons NH_3. When dissociated into its two constituents, 100 pounds of NH_3 will produce approximately 1100 cubic feet of nitrogen and 3400 cubic feet of hydrogen. *The advice and help of Barrett technical service men are yours for the asking.*

CHEMICAL AND PHYSICAL PROPERTIES

Molecular weight	17.03
Boiling point	—33.35°C (—28°F)
Freezing point	—77.7°C (—107.9°F)
Critical temperature	133.0°C (271.4°F)
Critical pressure	1657 lbs./sq. in. abs.
Latent heat (at — 28°F)	589.3 B.T.U./lb.
Specific gravity (1 atms 60°F Air = 1)	0.596 (.0456 lbs./cu. ft.)
Liquid density (at 60°F)	0.62 (38.55 lbs./cu. ft.)
Volume (1 atms 60°F)	22.0 cu. ft./lb.
Specific heat,	
Cp (1 atms 60°F)	0.52 cal./g.
Cv (1 atms 60°F)	0.39 cal./g.
Cp/Cv (1 atms 60°F)	1.32



Free *An interesting and helping booklet, packed with practical service information about Barrett Standard Anhydrous Ammonia, will be mailed you on request.*

THE BARRETT DIVISION
ALLIED CHEMICAL & DYE CORPORATION
40 RECTOR STREET, NEW YORK 6, N.Y.

Barrett

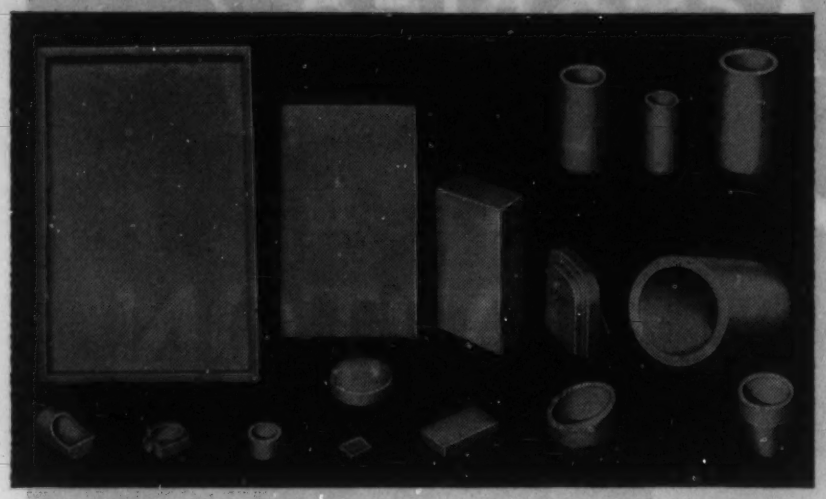
Special REFRACTORIES *for Higher Temperatures* by NORTON

NORTON REFRACTORIES

Working with the most refractory substances known—ALUNDUM (fused Al_2O_3), CRYSTOLON (SiC) and Fused Magnesia—Norton engineers have developed: (1) CRYSTOLON Hearth Plates which can double furnace output because their strength permits thin construction for high heat conductivity and their abrasion resistance cuts down replacement "stoppages"; (2) Refractory Cements for a wide variety of metal-melting furnaces (mostly non-ferrous) which can be rammed or tamped in place or applied as plastic mixtures and which remain chemically stable and unaffected under high temperatures long after less refractory and less stable cements deteriorate; (3) ALUNDUM Tubes, Cores and Muffles for heat-treating furnaces which withstand 24-hour operation at 1700° C with maximum refractory life.

NORTON COMPANY
Worcester 6, Massachusetts

STUBBORN VIRGIN



WESGO SUPER REFRACTORY slabs, boats, blocks, crucibles and other shapes stubbornly refuse to crack or spall, no matter how cataclysmic the temperature change.

IN FACT—no other non-metallic material will withstand as much thermal shock at high temperatures.

Wesgo shapes retain their virginity by refusing to associate with hydrogen, cracked ammonia and other furnace gases in spite of the opportunity created by intimate contact at high temperatures.

Perhaps you have a powdered metal sintering, brazing, annealing or melting operation in which a refractory shape having these characteristics would prove of great value.

WRITE US, PLEASE.

WESTERN GOLD AND PLATINUM WORKS

587 BRYANT STREET . . SAN FRANCISCO 7, CAL.

The *KING PORTABLE BRINELL*

The Portable Brinell that puts a load of

3000 KG. on a 10mm. Ball

—required to make a REAL BRINELL HARDNESS TEST.—

The KING PORTABLE BRINELL is an all around Brinell Tester, stationary as well as portable. Its PORTABILITY makes it indispensable for large parts and for saving time.

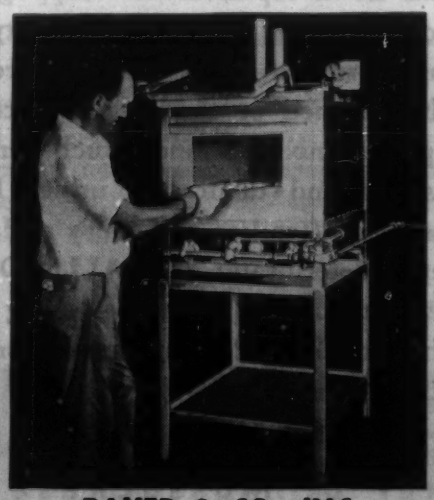
Throat 4" deep
Gap 10" high — Wt. 26 lb.

ANDREW KING
NARBERTH, PENNA.

BAKER GAS FURNACES

TEMPERATURES UP TO 2000° F.

Baker Blowerless Gas Furnaces are low in gas consumption, noiseless in operation and reach the required temperature rapidly. There are 9 standard stock models ranging from the bench type No. 1 to No. 24 (illustrated). Send for our catalog which gives full details and specifications.



BAKER & CO., INC.
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TOOLING FOR SPEED AND ACCURACY

★ The list of clients for whom Hecker has designed and built tools during the past fourteen years reads like the "blue book of American Industry." We are ready now to help with your retooling problems. Write for our new brochure "Men and Machines."

A.W. HECKER
ENGINEERS *and Tool Makers*
Established 1931

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THIS LINDBERG BRAZING FURNACE GIVES YOU

Gain in Furnaces

You can use this new completely engineered furnace for:

1 High temperature copper brazing
2 Low temperature silver brazing
3 Sintering of powder metals
4 General tool hardening
5 High speed tool hardening
6 Bright annealing

Keep it as busy as you can with brazing, but if your brazing production is irregular this furnace offers ideal facilities for any other heat treating operation requiring a protective atmosphere. A mid-west manufacturer, for example, hardens the dies used for forming the parts to be brazed.

Globar elements develop a temperature up to 2500° F. At copper brazing temperatures of 2050° F., the Globar elements are not forced to their full heating capacity and the additional degrees up to 2500° F. allow plenty of range in which to heat any of the high speed tool steels for hardening and also for sintering certain powder metals. These non-metallic elements are easily replaced in a few minutes without cooling down the furnace, virtually eliminating production delays. A choice of protective atmospheres allows treatment of any kind of steel.

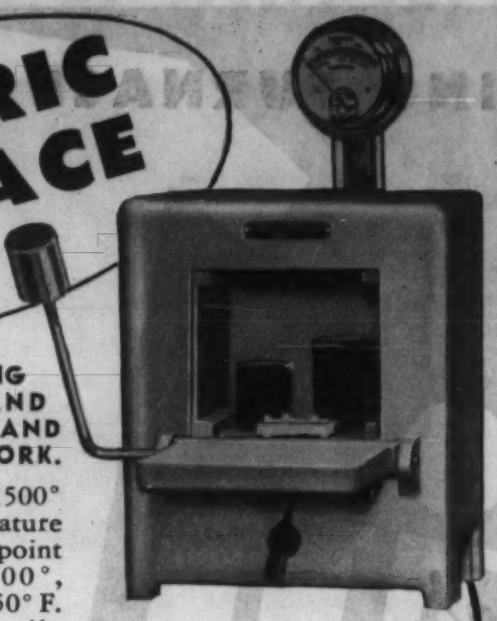
Find out all about this versatile hand-pusher type furnace. Write now for bulletin 200. Lindberg Engineering Company, 2451 W. Hubbard Street, Chicago 12, Illinois.

LINDBERG *Furnaces*

SUPER-CYCLONE • CYCLONE • HYDRYZING • BRAZING

TEMCO ELECTRIC FURNACE

MODEL GRP



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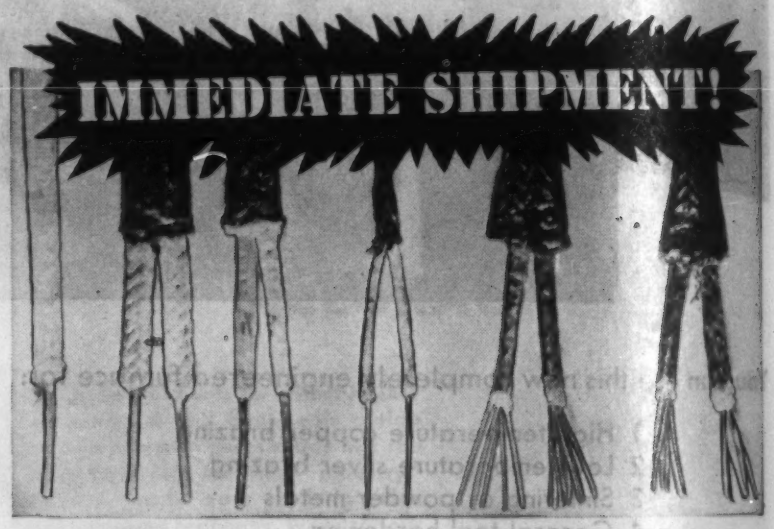

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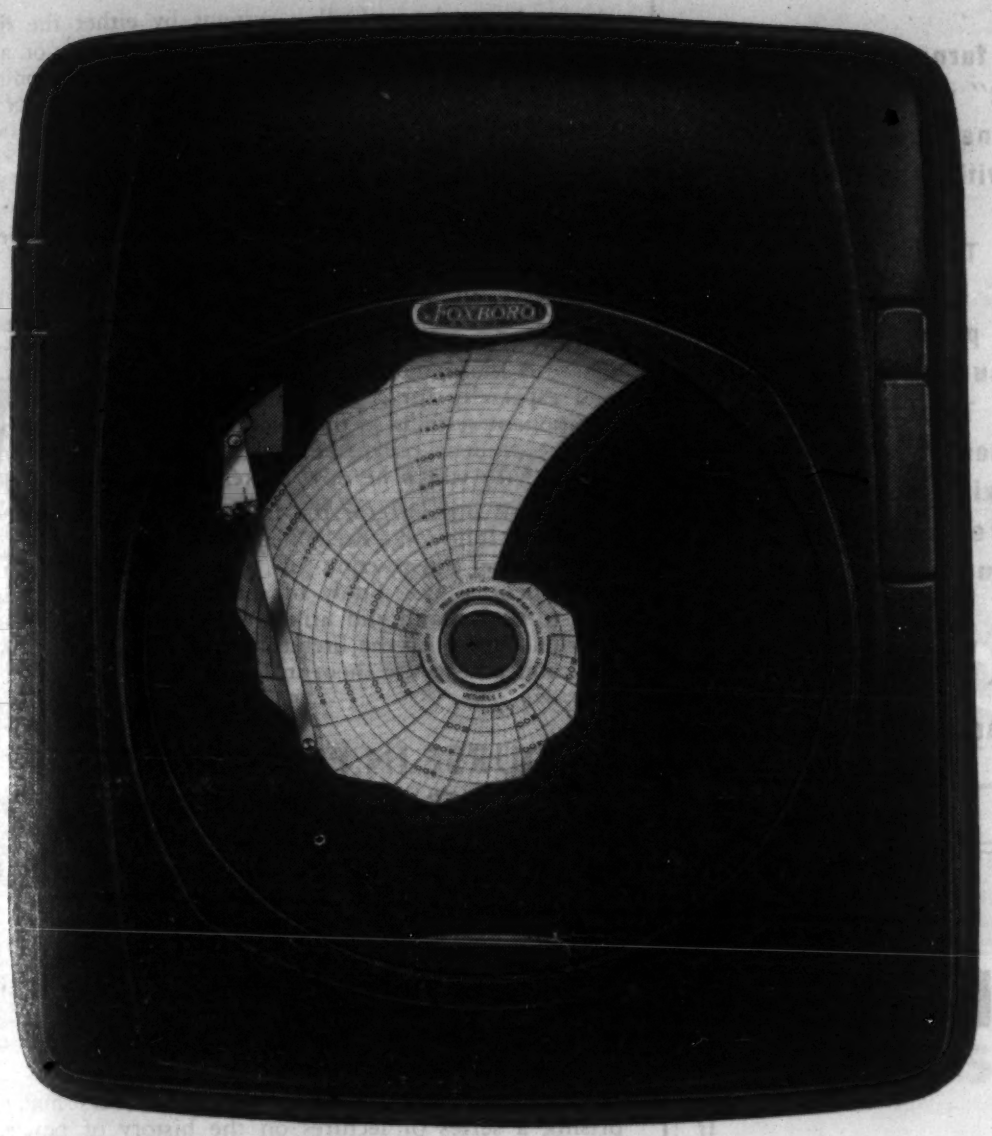

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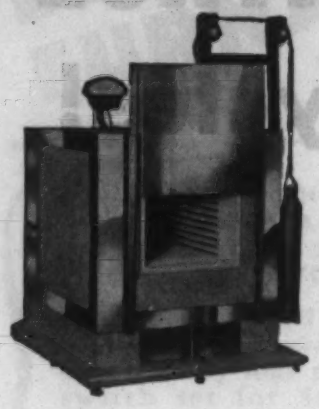

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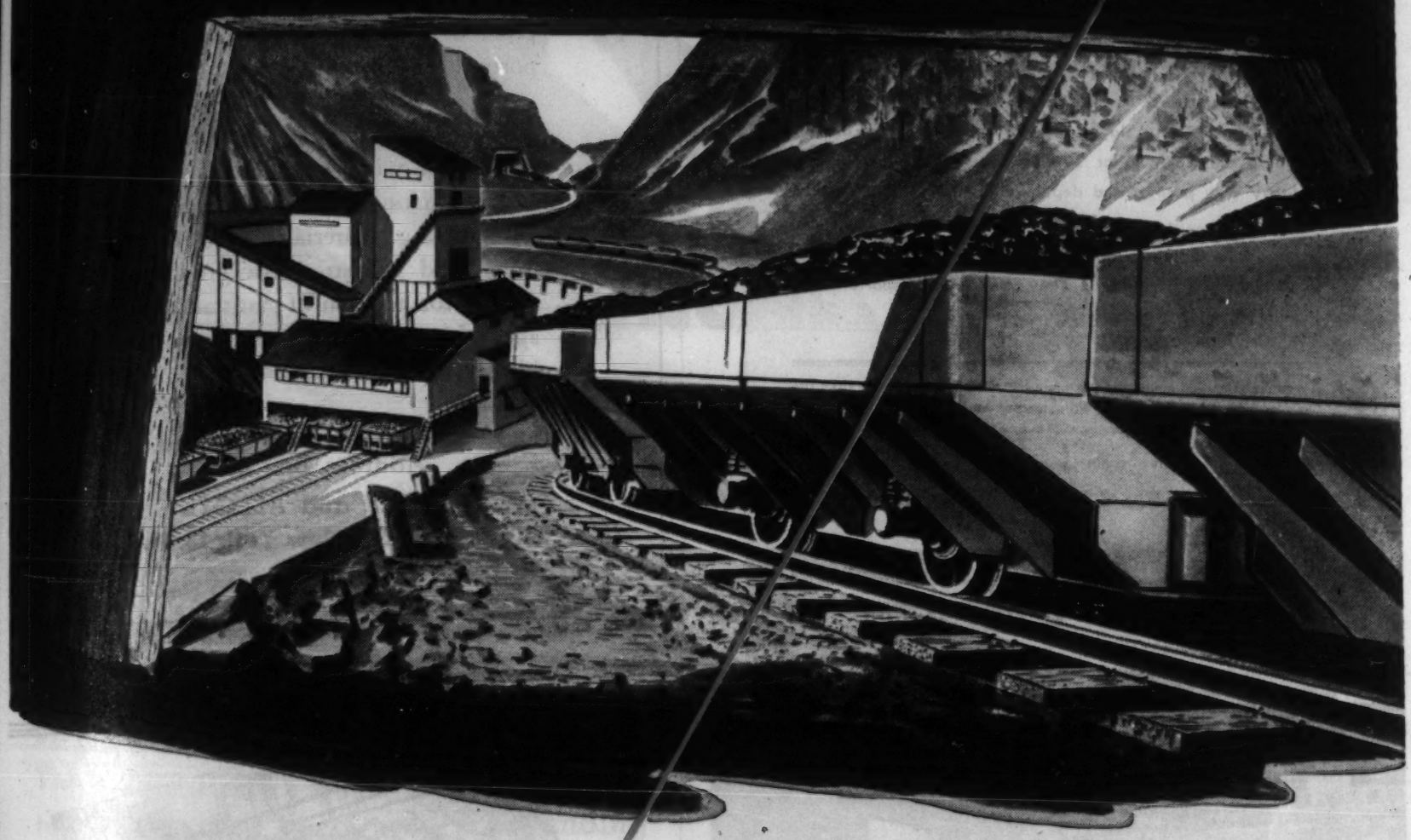

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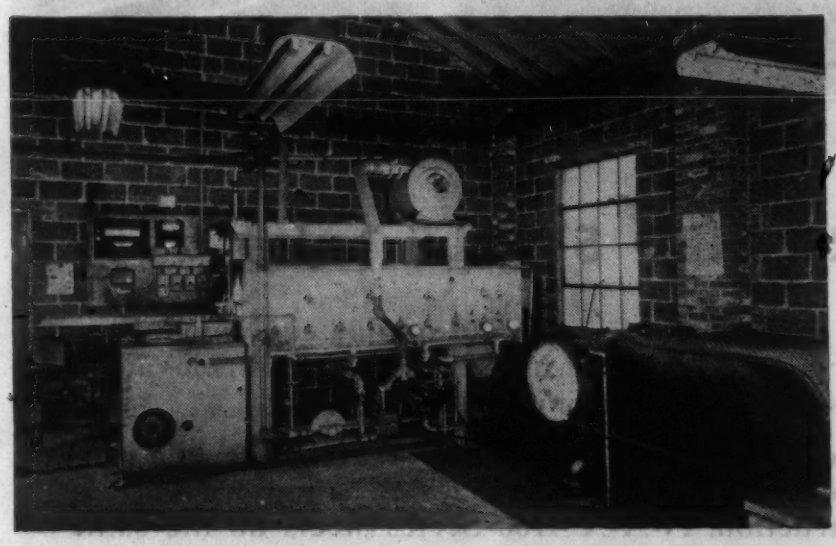

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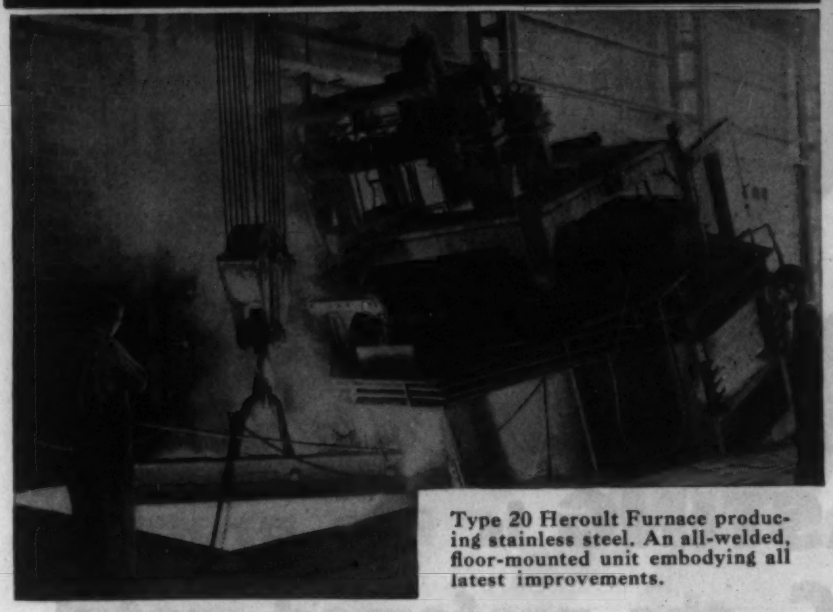

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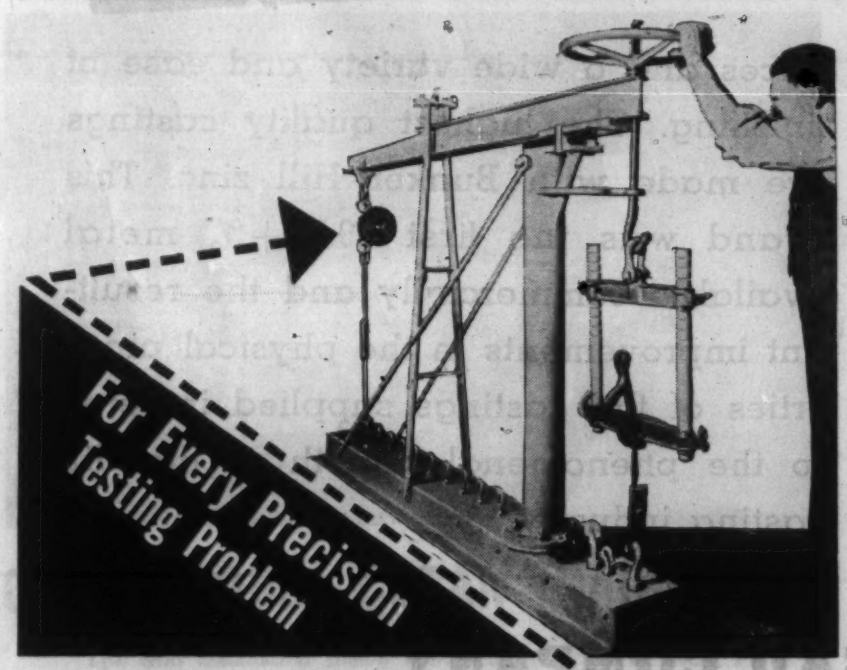

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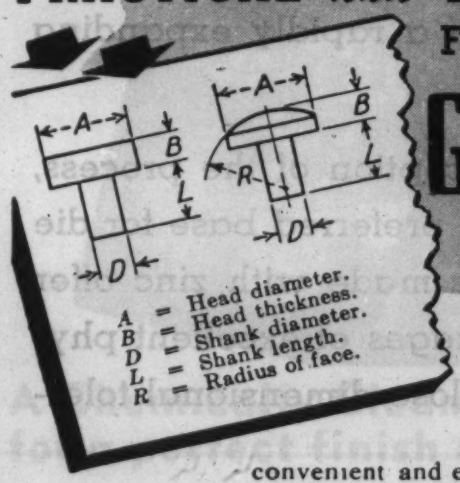

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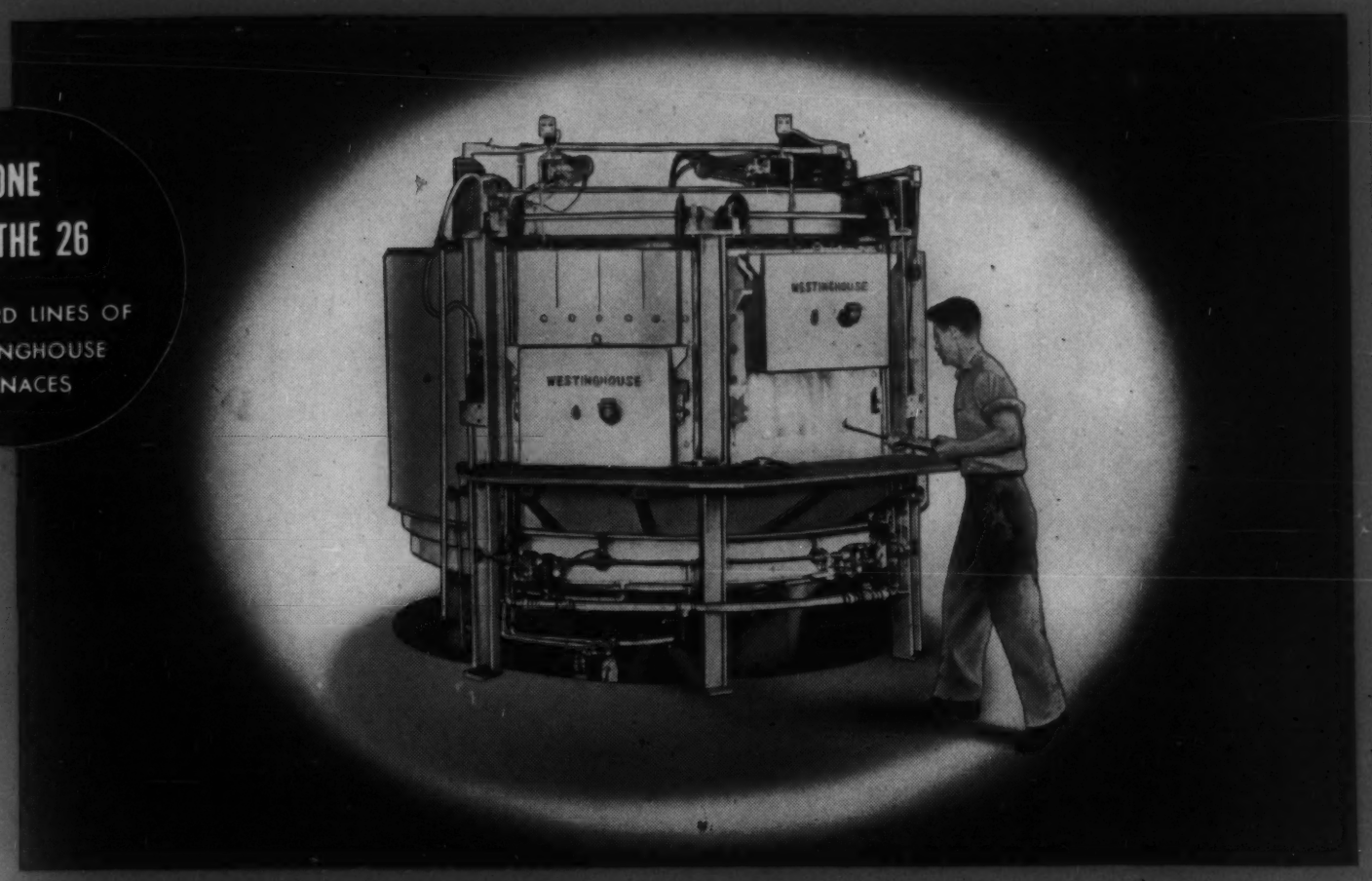

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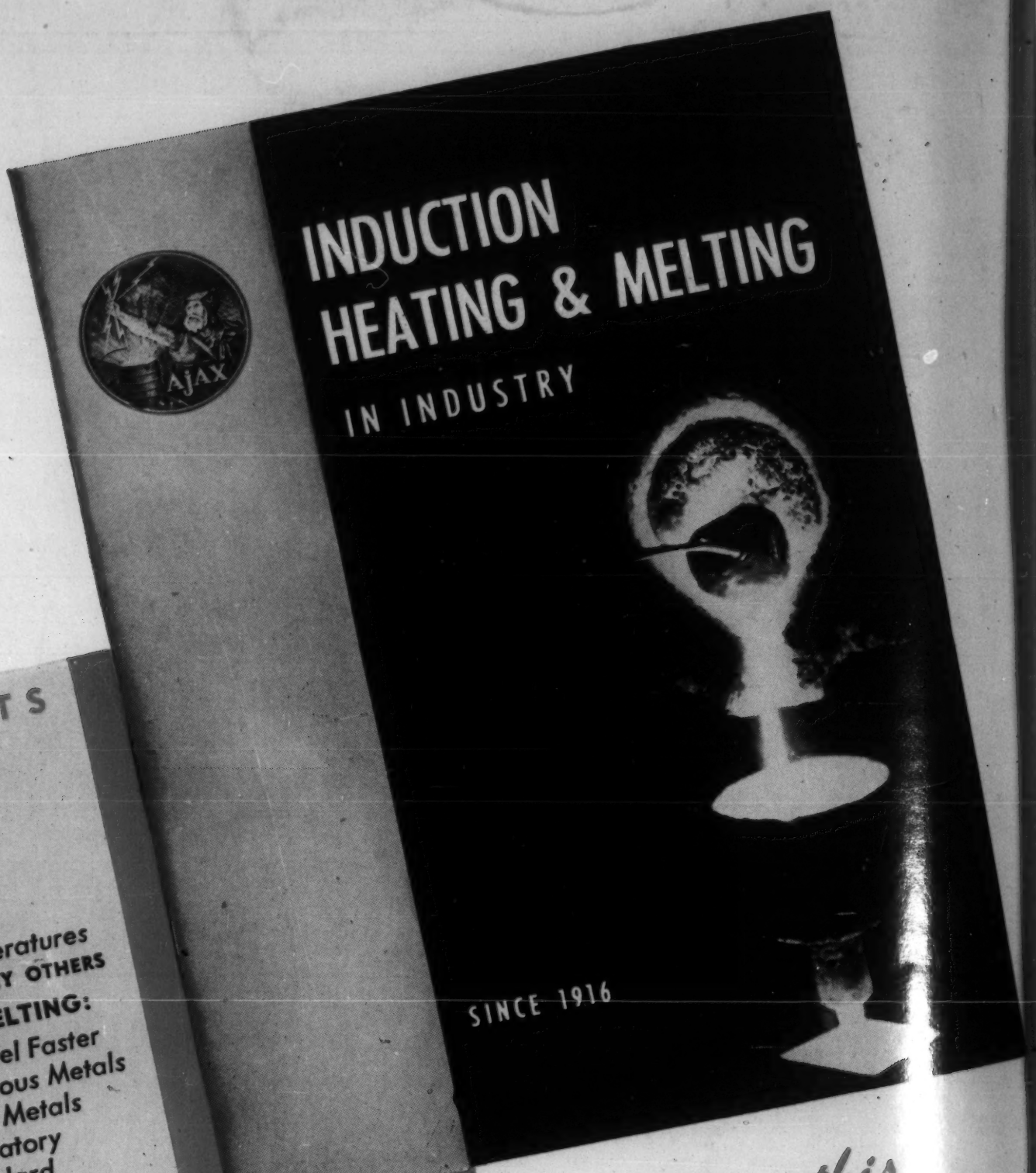

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